CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

CIVILENGINEERING

SEMESTERS I TO VIII

2020 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

B. TECH DEGREE PROGRAMME

IN

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(SEMESTERS I TO VIII)

Items	Board of Studies (BoS)	Academic Council (AC)
Dates of Approval	16.11.2020	30.12.2020
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	28.02.2023	20.03.2023

Head of Department
Chairman, Board of Studies
Dr. JISHA S.V.
Associate Professor & HoD
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Mar Baselios College of Engineering & Technology
Nalanchira, Thiruvananthapuram-695015

COLLEGE OF ENGINEERING & TECHNOLOGY (Autonomous) Mar Ivanios Vidyanagar Nalanchira Thiruvananthapuram-695015 MAR BASELIOS

28/03/2023
Principal
Chairman, Academic Council
Principal
Mar Baselios College
of Engineering & Technology
Mar Ivanios Vidyanagar, Nalanchira
Thiruvananthapuram-695015

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF CIVIL ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Civil Engineering education with a global perspective, creating ethically strong engineers for the service of society.

Mission:

To provide Engineering Education which can create exemplary professional Civil Engineers of high ethics with strong conceptual foundation coupled with practical insight, to serve the industry and community.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates of the Programme will have a successful career as Civil Engineering practitioners, entrepreneurs or professionals, addressing the needs of the industry with a global perspective.

PEO2: They will contribute to society as ethical and responsible citizens with proven expertise

PEO3: They will engage in continuous professional development and advance to leadership roles in their chosen career.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review 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 the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
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 the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary 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 the 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Provide feasible and sustainable solutions to problems in various Civil Engineering disciplines such as Structural, Environmental, Geotechnical, Transportation and Construction Engineering.

PSO2: Apply the principles, methods, software and codes of practices to design various Civil Engineering Systems.

DEPARTMENT OF CIVIL ENGINEERING

B.Tech. Programme in Civil Engineering

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B.Tech Programme is placed in one of the nine categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Total credits
1	Humanities and Social Sciences including Management Courses	HSC	8
2	Basic Science Courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	76
5	Programme Elective Courses	PEC	15
6	Open Elective Courses	OEC	3
7	Project Work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	---
9	Mandatory Student Activities (P/F)	MSA	2
	Total Mandatory Credits		**162**
	Value Added Courses (Optional) – Honours/Minor	VAC	20

ii) Semester-wise Credit Distribution

<table>
<tr><th>Semester</th><th>I</th><th>II</th><th>III</th><th>IV</th><th>V</th><th>VI</th><th>VII</th><th>VIII</th><th>Total Credits</th></tr>
<tr><td>Credits for Courses</td><td>17</td><td>21</td><td>22</td><td>22</td><td>23</td><td>23</td><td>15</td><td>17</td><td>160</td></tr>
<tr><td>Activity Points (Min.)</td><td colspan="4">40</td><td colspan="4">60</td><td>100</td></tr>
<tr><td>Credits for Activities</td><td colspan="8">2</td><td>2</td></tr>
<tr><td colspan="9">Total Credits</td><td>162</td></tr>
<tr><td colspan="9">Value Added Courses (Optional) – Honours / Minor</td><td>20</td></tr>
<tr><td colspan="9">Total Credits</td><td>182</td></tr>
</table>

SEMESTER I						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10A	Linear Algebra and Calculus	3-1-0	4	4
B 1/2	BSC	PH0U10B	Engineering Physics B	3-1-0	4	4
		CY0U10A	Engineering Chemistry	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10A	Life Skills	2-0-2	4	---
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
			TOTAL		**23/24**	**17**

SEMESTER II						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10B	Vector Calculus, Differential Equations and Transforms	3-1-0	4	4
B 1/2	BSC	PH0U10B	Engineering Physics B	3-1-0	4	4
		CY0U10A	Engineering Chemistry	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10B	Professional Communication	2-0-2	4	---
F	ESC	ES0U10E	Programming in **C**	2-1-2	5	4
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
			TOTAL		**28/29**	**21**

SEMESTER III						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20A	Partial Differential Equations and Complex Analysis	3-1-0	4	4
B	PCC	CE1U20A	Mechanics of Solids	3-1-0	4	4
C	PCC	CE1U20B	Fluid Mechanics and Hydraulics	3-1-0	4	4
D	PCC	CE1U20C	Surveying and Geomatics	4-0-0	4	4
E 1/2	ESC	ES0U20A	Design & Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20A	Sustainable Engineering	2-0-0	2	---
S	PCC	CE1U28A	Civil Engineering Planning and Drafting Lab	0-0-3	3	2
T	PCC	CE1U28B	Survey Lab	0-0-3	3	2
R/M			Remedial/Minor Course	3-1-0/ 4-0-0	4	4
			TOTAL		**26/30**	**22/26**

SEMESTER IV						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20D	Probability, Statistics and Numerical Methods	3-1-0	4	4
B	PCC	CE1U20D	Engineering Geology	3-0-1	4	4
C	PCC	CE1U20E	Geotechnical Engineering I	4-0-0	4	4
D	PCC	CE1U20F	Transportation Engineering	3-1-0	4	4
E 1/2	ESC	ES0U20A	Design & Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20B	Constitution of India	2-0-0	2	---
S	PCC	CE1U28C	Material Testing Lab I	0-0-3	3	2
T	PCC	ME0U28A	Fluid Mechanics Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
			TOTAL		**26/30**	**22/26**

SEMESTER V						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CE1U30A	Structural Analysis I	3-1-0	4	4
B	PCC	CE1U30B	Design of Concrete Structures	3-1-0	4	4
C	PCC	CE1U30C	Geotechnical Engineering II	4-0-0	4	4
D	PCC	CE1U30D	Hydrology and Water Resource Engineering	4-0-0	4	4
E	PCC	CE1U30E	Construction Technology and Management	3-0-0	3	3
F	HSC	NC0U30A	Disaster Management	2-0-0	2	--
S	PCC	CE1U38A	Material Testing Lab II	0-0-3	3	2
T	PCC	CE1U38B	Geotechnical Engineering Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
			TOTAL		**27/31**	**23/27**

SEMESTER VI						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CE1U30F	Structural Analysis II	3-1-0	4	4
B	PCC	CE1U30G	Environmental Engineering	4-0-0	4	4
C	PCC	CE1U30H	Design of Hydraulic Structures	4-0-0	4	4
D	PEC	CE1UXXX	Program Elective I	3-0-0	3	3
E	HSC	HS0U30A	Industrial Economics and Foreign Trade	3-0-0	3	3
F	PCC	CE1U30I	Comprehensive Course work	1-0-0	1	1
S	PCC	CE1U38C	Transportation Engineering Lab	0-0-3	3	2
T	PCC	CE1U38D	Civil Engineering Software Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
			TOTAL		**25/29**	**23/27**

PROGRAMME ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CE1U31A	Advanced Computational Methods	3-0-0	3	3
		CE1U31B	Geotechnical Investigation	3-0-0	3	3
		CE1U31C	Traffic Engineering and Management	2-1-0	3	3
		CE1U31D	Mechanics of Fluid Flow	3-0-0	3	3
		CE1U31E	Advanced Concrete Technology	3-0-0	3	3
		CE1U31F	Environmental Impact Assessment	3-0-0	3	3
		CE1U31G	Functional Design of Buildings	3-0-0	3	3

SEMESTER VII						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CE1U40A	Design of Steel Structures	3-0-0	3	3
B	PEC	CE1UXXX	Program Elective II	3-0-0	3	3
C	OEC	CE0UXXX	Open Elective	3-0-0	3	3
D	MNC	NC0U40A	Industrial Safety Engineering	2-1-0	3	----
S	PCC	CE1U48A	Environmental Engineering Lab	0-0-3	3	2
T	PWS	CE1U49A	Seminar	0-0-3	3	2
U	PWS	CE1U49B	Project Phase I	0-0-6	6	2
R/M/H	VAC		Remedial/Minor/Honours Course	0-1-6/ 3-1-0/ 4-0-0	7/4	4
			TOTAL		**24/ (31/28)**	**15/19**

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	CE1U41A	Prestressed Concrete	3-0-0	3	3
		CE1U41B	Ground Improvement Techniques	3-0-0	3	3
		CE1U41C	Highway Materials and Design	2-1-0	3	3
		CE1U41D	Applied Hydrology	3-0-0	3	3
		CE1U41E	Construction Planning and Management	3-0-0	3	3
		CE1U41F	Advanced Environmental Engineering	3-0-0	3	3
		CE1U41G	Optimisation Techniques in Civil	3-0-0	3	3

			Engineering			
		CE1U41H	Municipal Solid Waste Management	3-0-0	3	3
		CE1U41J	Applied Soil Mechanics	3-0-0	3	3
		CE1U41K	Advanced Structural Analysis	3-0-0	3	3

OPEN ELECTIVE

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	OEC	CE0U41A	Introduction to Environmental Impact Assessment	2-1-0	3	3
		CE0U41B	Applied Earth Systems	2-1-0	3	3
		CE0U41C	Infrastructure Management with Informatics	2-1-0	3	3
		CE0U41D	Disaster Management	2-1-0	3	3
		CE0U41E	Environmental Health and Safety	2-1-0	3	3
		CE0U41F	Geoinformatics	2-1-0	3	3

SEMESTER VIII						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CE1U40B	Quantity Surveying and Valuation	3-0-0	3	3
B	PEC	CE1UXXX	Program Elective III	3-0-0	3	3
C	PEC	CE1UXXX	Program Elective IV	3-0-0	3	3
D	PEC	CE1UXXX	Program Elective V	3-0-0	3	3
T	PCC	CE1U40C	Comprehensive Viva Voce	1-0-0	1	1
U	PWS	CE1U49C	Project Phase II	0-0-12	12	4
R/M/H	VAC		Remedial/Minor/Honours Course	0-1-6	7	4
			TOTAL		**25/32**	**17/21**

PROGRAMME ELECTIVE III

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	CE1U42A	Advanced Design of RCC structures and light gauge members	3-0-0	3	3
		CE1U42B	Geo-environmental Engineering	3-0-0	3	3

		CE1U42C	Railway and Tunnel Engineering	2-1-0	3	3
		CE1U42D	Irrigation and Drainage Engineering	3-0-0	3	3
		CE1U42E	Construction Methods and Equipment	3-0-0	3	3
		CE1U42F	Air Quality Management	3-0-0	3	3
		CE1U42G	Urban Planning and Architecture	3-0-0	3	3
		CE1U42H	Wind Analysis on Structures, Cladding and Glazing Components	3-0-0	3	3

PROGRAMME ELECTIVE IV

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	PEC	CE1U43A	Bridge Engineering	3-0-0	3	3
		CE1U43B	Advanced Foundation Engineering	3-0-0	3	3
		CE1U43C	Transportation Planning	2-1-0	3	3
		CE1U43D	Informatics for Infrastructure Management	3-0-0	3	3
		CE1U43E	Repair, Rehabilitation and Retrofitting of Structures	3-0-0	3	3
		CE1U43F	Environmental Remote Sensing	3-0-0	3	3
		CE1U43G	Building Services	3-0-0	3	3

PROGRAMME ELECTIVE V

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CE1U44A	Earthquake Resistant Design	3-0-0	3	3
		CE1U44B	Soil Structure Interaction	3-0-0	3	3
		CE1U44C	Airport, Seaport and Harbour Engineering	3-0-0	3	3
		CE1U44D	Hydroclimatology	3-0-0	3	3
		CE1U44E	Sustainable Construction	3-0-0	3	3
		CE1U44F	Climate Change and Sustainability	3-0-0	3	3
		CE1U44G	Building Information Modelling	3-0-0	3	3
		CE1U44H	Geotechnical Earthquake Engineering	3-0-0	3	3

MINORS AND HONOURS BASKET

MINORS IN CIVIL ENGINEERING

Semester	BASKET I				BASKET II				BASKET III				BASKET IV			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S3	CEOM 20A	Building Construction and Structural Systems	4-0-0	4	CEOM2 0B	Introduction to Geotechnical Engineering	4-0-0	4	CEOM2 0C	Informatics for Infrastructure Management	3-1-0	4	CEOM 20D	Building Technology and Interior Designing	3-1-0	4
S4	CEOM 20E	Building Drawing	2-2-0	4	CEOM2 0F	Introduction to Transportation Engineering	3-1-0	4	CEOM2 0G	Climate Change and Hazard Mitigation	4-0-0	4	CEOM 20H	Building Drawing and Estimation	4-0-0	4
S5	CEOM 30A	Structural Mechanics	4-0-0	4	CEOM3 0B	Eco-Friendly Transportation Systems	3-1-0	4	CEOM3 0C	Sustainability Analysis and Design	4-0-0	4	CEOM 30D	Sensing and Data Mining for Smart Structures and Systems	4-0-0	4
S6	CEOM 30E	Estimation and Costing	4-0-0	4	CEOM3 0F	Geotechnical Investigation and Ground Improvement Techniques	4-0-0	4	CEOM3 0G	Environmental Health and Safety	4-0-0	4	CEOM 30H	Construction Quality Management	4-0-0	4
S7	CEOM 49A	Mini Project	0-1-6	4	CEOM4 9A	Mini Project	0-1-6	4	CEOM4 9A	Mini Project	0-1-6	4	CEOM 49A	Mini Project	0-1-6	4
S8	CEOM 49B	Mini Project	0-1-6	4	CEOM4 9B	Mini Project	0-1-6	4	CEOM4 9B	Mini Project	0-1-6	4	CEOM 49B	Mini Project	0-1-6	4

HONOURS IN CIVIL ENGINEERING

Semester	BASKET I				BASKET II				BASKET III			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S4	CE1H 20A	Advanced Mechanics of Solids	3-1-0	4	CE1H 20B	Pavement Construction and Management	3-1-0	4	CE1H 20C	Geographical Information Systems	4-0-0	4
S5	CE1H 30A	Structural Dynamics	4-0-0	4	CE1H 30B	Transportation Systems Management	3-1-0	4	CE1H 30C	Ground Water Hydrology	4-0-0	4
S6	CE1H 30D	Finite Element Methods	4-0-0	4	CE1H 30E	Earth Dams and Earth Retaining Structures	4-0-0	4	CE1H 30F	Environmental Pollution Modelling	4-0-0	4
S7	CE1H 40A	Modern Construction Materials	4-0-0	4	CE1H 40B	Soil Dynamics and Machine Foundations	4-0-0	4	CE1H 40C	Environmental Pollution Control Techniques	4-0-0	4
S8	CE1H 49A	Mini Project	0-1-6	4	CE1H 49A	Mini Project	0-1-6	4	CE1H 49A	Mini Project	0-1-6	4

SEMESTER – I

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U10A	LINEAR ALGEBRA AND CALCULUS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW:

This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analysing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analysing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Solve systems of linear equations.	Apply
CO 2	Compute maxima and minima using partial derivatives.	Evaluate
CO 3	Compute areas and volumes of geometrical shapes using multiple integrals.	Evaluate
CO 4	Identify the convergence or divergence of an infinite series.	Evaluate
CO 5	Determine the Taylor and Fourier series expansion of functions and learn their applications.	Apply

iii) SYLLABUS

Basics of Linear Algebra – Solution of systems of linear equations, row echelon form, rank, eigen values and eigen vectors, diagonalization of matrices, orthogonal transformation, quadratic forms.

Partial Differentiation and Applications – Limit and continuity of functions of two or more variables, partial derivatives, chain rule, total derivatives, maxima and minima.

Multiple Integrals – Double and triple integrals, double integrals over rectangular and non-rectangular regions, changing the order of integration, finding areas and volume, mass and centre of gravity.

Infinite series – Convergence and divergence of Infinite series, geometric series and p-series, test of convergence, Alternating series, absolute and conditional convergence

Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions –Fourier Series– Euler's formulas, Fourier sine and cosine series, Half range expansions

iv) (a) TEXT BOOKS

1) H. Anton, I. Biven, S. Davis, Calculus, Wiley, 10th Edition, 2015.

2) Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley & Sons, 2016.

(b) REFERENCES

1) J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017

2) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

3) Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Linear Algebra: Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and eigen vectors. Diagonalization of matrices, orthogonal transformation, quadratic forms and their canonical forms.	**12**
II	Multivariable calculus-Differentiation: Concept of limit and continuity of functions of two variables, partial derivatives, Differentials, Local Linear approximations, chain rule, totalderivative, Relative maxima and minima, Absolute maxima and minima on closed and bounded set.	**12**
III	Multivariable calculus-Integration: Double integrals (Cartesian), reversing the order of integration, change of coordinates (Cartesian to polar), finding areas and volume using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).	**12**
IV	Sequences and Series: Convergence of sequences and series, convergence of geometric series and p-series(without proof), test of convergence (comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.	**12**
V	Series representation of functions: Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formulas, Convergence of Fourier series (without proof), half range sine and cosine series, Parseval's theorem (without proof).	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U10B	ENGINEERING PHYSICS B	BSC	3	1	0	4	2020

i) COURSE OVERVIEW:

The aim of the course is to develop scientific attitude in students and offer them an understanding of physical concepts behind various engineering applications. It creates an urge in students to think creatively in emerging areas of Physics.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the characteristics of different types of oscillations and waves.	Remember
CO 2	Apply the principles of wave optics to explain natural physical processes and related technological advances.	Understand
CO 3	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.	Understand
CO 4	Apply the knowledge of ultrasonics in non-destructive testing and use the principles of acoustics to explain the nature and characterization of acoustic design	Understand
CO 5	Apply the comprehended knowledge about laser and fibre optic communication systems in various engineering applications.	Apply

iii) SYLLABUS

Oscillations and Waves: Damped oscillations, Forced oscillations, One dimensional and three-dimensional wave equations, Transverse vibrations along a stretched string
Wave Optics: Interference of light- Air wedge, Newton’s rings, Antireflection coating, Diffraction -Fraunhofer diffraction at a single slit, Grating equation, Rayleigh’s criterion
Quantum Mechanics & Nanotechnology: Wave function, Time dependent and time independent Schrodinger wave equations, One-dimensional potential well
Introduction to nanoscience and technology, Quantum confinement, Properties of nanomaterials
Acoustics &Ultrasonics: Acoustics, characteristics of musical sounds, absorption coefficient, reverberation time-significance- Sabine’s formula (no derivation), factors affecting architectural acoustics and their remedies.
Ultrasonics-production by magnetostriction oscillator and piezoelectric oscillator, detection of ultrasonic waves - thermal and piezoelectric methods, ultrasonic diffractometer-, applications of ultrasonic waves -SONAR, NDT
Laser and Fibre optics: Properties of laser, Ruby laser and Helium neon laser, Holography-Recording and reconstruction
Optical fibre -Principle, Numerical aperture, Types of fibres, Applications.

iv)(a) TEXT BOOKS

1) M.N. Avadhanulu , P.G. Kshirsagar, T.V.S Arun Murthy, *A Text book of Engineering Physics*, S.Chand&Co., Revised Edition, 2014
2) H.K. Malik, A.K. Singh, *Engineering Physics,* McGraw Hill Education, 2nd Edition, 2017

(b) REFERENCES

1) Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw Hill Publications, 6thEdition, 2003.
2) Aruldhas G., *Engineering Physics*, Prentice Hall of India Pvt. Ltd., 2015
3) Ajoy Ghatak, *Optics*, Mc Graw Hill Education, 6th Edition, 2017
4) David J. Griffiths, *Introduction to Electrodynamics*, Addison-Wesley publishing, 3rd Edition, 1999.
5) Premlet B., *Advanced Engineering Physics*, Phasor Books, 10th Edition, 2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	Oscillations and Waves: Harmonic oscillations, damped harmonic motion-derivation of differential equation and its solution, over damped, critically damped and under damped cases, Quality factor-expression, forced oscillations-differential equation-derivation of expressions for amplitude and phase of forced oscillations, amplitude resonance-expression for resonant frequency, Quality factor and sharpness of resonance, electrical analogy of mechanical oscillators Wave motion- derivation of one-dimensional wave equation and its solution, three-dimensional wave equation and its solution (no derivation), distinction between transverse and longitudinal waves, transverse vibration in a stretched string, statement of laws of vibration	12
II	Wave Optics: Interference of light-principle of superposition of waves, theory of thin films - cosine law (Reflected system), derivation of the conditions of constructive and destructive interference, interference due to wedge shaped films -determination of thickness and test for optical planeness, Newton's rings - measurement of wavelength and refractive index, antireflection coatings. Diffraction of light, Fresnel and Fraunhofer classes of diffraction, diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, resolving and dispersive power of a grating with expression (no derivation)	12
III	Quantum Mechanics & Nanotechnology: Introduction for the need of Quantum mechanics, wave nature of Particles, uncertainty principle, Applications-absence of electrons inside a nucleus and natural line broadening mechanism, formulation of time dependent and independent Schrodinger wave equations-physical meaning of wave function, Particle in a one dimensional box- derivation for normalised	12

	wave function and energy eigen values, Quantum mechanical tunnelling (qualitative). Introduction to nanoscience and technology, increase in surface to volume ratio for nanomaterials, quantum confinement in one dimension, two dimension and three dimension-nano sheets, nano wires and quantum dots, properties of nanomaterials-mechanical, electrical and optical, applications of nanotechnology (qualitative ideas)	
IV	Acoustics &Ultrasonics: Acoustics, Classification of sound-Musical sound-Noise, Characteristics of Musical Sounds-Pitch or frequency-Loudness or Intensity Measurement of Intensity level-Decibel-Quality or timbre, Absorption coefficient, Reverberation-Reverberation time-Significance- Sabine's formula (no derivation).Factors affecting architectural acoustics and their remedies. Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator – Working, Detection of ultrasonic waves - Thermal and Piezoelectric methods. Ultrasonic diffractometer- Expression for the velocity of ultrasonic waves in a liquid , Applications of ultrasonic waves - SONAR,NDT and Medical.	**12**
V	Laser and Fibre optics: Properties of laser, Absorption and emission of radiation, Spontaneous and stimulated emission, Einstein's coefficients (no derivation), Population inversion, Metastable states, basic components of laser, Active medium, Pumping mechanism, Optical resonant cavity, working principle. Construction and working of Ruby laser and Helium neon laser, Construction and working of semiconductor laser (Qualitative) Applications of laser. Holography, Difference between hologram and photograph, Recording of hologram and reconstruction of image, Applications. Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications, Fibre optic sensors-Intensity Modulated and Phase modulated sensors	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10B	ENGINEERING GRAPHICS	ESC	2	0	2	4	2020

i) COURSE OVERVIEW:

Aim of the course is to enable the student to effectively perform technical communication through graphical representation as per global standards. The student will be able to apply the principles of projection and will be introduced to the fundamentals of Computer Aided Drawing (CAD).

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Construct the orthographic projection of points and lines located in different quadrants.	Apply
CO 2	Prepare multiview orthographic projection of solids by visualizing them in different positions.	Apply
CO 3	Construct sectional views and develop surfaces of a given solid.	Apply
CO 4	Prepare pictorial drawings using the principles of isometric and perspective projection to visualize objects in three dimensions.	Apply
CO 5	Convert pictorial views into orthographic views.	Apply
CO 6	Prepare multiview projection and solid models of objects using CAD tools.	Apply

iii) SYLLABUS

Introduction - Relevance of technical drawing in engineering field, BIS code of practice for technical drawing.

Orthographic projection - Projection of points and lines in different quadrants, traces of line. Projection of solids in simple position, axis inclined to one reference plane and axis inclined to both reference planes.

Sections of Solids - Sections of solids cut by different section planes, true shape of the sections

Development of Surfaces - Development of surfaces of solids and solids cut by different section planes.

Isometric Projection - Isometric view and projection of solids and their combinations.

Perspective Projection - Perspective projection of solids with axis perpendicular to the ground plane.

Conversion of Pictorial Views - Conversion of pictorial views into orthographic views.

Introduction to Computer Aided Drawing - Creating 2D drawing and 3D models of various components using suitable modelling software.

iv) (a) TEXT BOOKS

1) Bhatt N.D, *Engineering Drawing*, Charotar Publishing House Pvt. Ltd, 53rd Edition, 2019.
2) John K.C., *Engineering Graphics*, Prentice Hall India Publishers, 1st Edition, 2009.
3) C. M. Agrawal, Basant Agrawal, *Engineering Graphics*, Tata McGraw-Hill, 1stEdition, 2012.

(b) REFERENCES

1) G. S. Phull, H. S. Sandhu, *Engineering Graphics*, John Wiley & Sons Inc Pvt. Ltd, 1stEdition, 2014.
2) P. I. Varghese, *Engineering Graphics*, V.I.P. Publishers, 21st Edition, 2010.
3) Anil Kumar K.N., *Engineering Graphics*, Adhyuth Narayan Publishers, 4th Edition, 2009.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Relevance of technical drawing in engineering field. Types of lines, dimensioning, BIS code of practice for technical drawing. Orthographic projection of points and lines: Projection of points in different quadrants, projection of straight lines inclined to one plane and inclined to both planes. Trace of line, inclination of lines with reference planes, true length of line inclined to both the reference planes.	8
II	Orthographic projection of solids: Projection of simple solids such as triangular, rectangle, square, pentagonal and hexagonal prisms, pyramids, cone and cylinder. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.	9
III	Sections of Solids: Sections of prisms, pyramids, cone, cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Locating the section plane when the true shape of the section is given. Development of surfaces: Development of surfaces of the above solids and solids cut by different section planes. Finding the shortest distance between two points on the surface.	9
IV	Isometric projection: Isometric view and projection of prisms, pyramids, cone, cylinder, frustum of pyramid, frustum of cone, sphere, hemisphere and their combinations.	6

V	Perspective projection: Perspective projection of prisms and pyramids with axis perpendicular to the ground plane. Conversion of pictorial view: Conversion of pictorial view into orthographic views.	**5**
	SECTION B *(To be conducted in CAD Lab)*	
	Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software. (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software. (Minimum 2 exercises mandatory)	**8**
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment for Section A (15 marks for 1 test and 10 marks for classwork)	:	25 marks
Continuous Assessment for Section B (10 marks for 1 test and 5 marks for classwork)	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10D	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	ESC	4	0	0	4	2020

i) COURSE OVERVIEW

This course aims to equip the students with an understanding of the fundamental principles of electrical, electronics and communication engineering.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply fundamental circuit laws and principles of electromagnetism to solve simple DC electric circuits and magnetic circuits respectively.	Apply
CO 2	Describe the fundamentals of AC generation to perform simple AC circuit analysis.	Understand
CO 3	Describe the principles of passive components, semiconductor devices and its characteristics.	Understand
CO 4	Explain the working of electronic circuits, instrumentation, radio and cellular communication systems.	Understand

iii) SYLLABUS

Basic concepts of DC circuits: Ohm’s Law and Kirchhoff's laws, Star-delta conversion, Analysis of DC circuits, Mesh analysis, Node analysis.

Magnetic Circuits: Basic Terminology, Simple Magnetic circuits, Electromagnetic Induction, Faraday's laws, Lenz's law, Self-inductance and mutual inductance.

Alternating Current fundamentals: Basic definitions, Average, RMS values, AC Circuits, Phasor representation, Analysis of simple AC circuits (R, L, C, RL, RC, RLC Series circuits) Three phase AC systems, Generation of three phase voltages, star and delta connections.

Introduction to Semiconductor devices: Evolution of electronics, Resistors, Capacitors, Inductors PN Junction diodes and Bipolar Junction Transistors.

Basic electronic circuits and instrumentation: DC power supply, Full wave bridge rectifier, Capacitor filter, Simple Zener voltage regulator, Amplifiers, Public Address system and Electronic Equipment.

Introduction to Communication Systems: Evolution of communication systems, Radio communication, Principle of antenna and Mobile communication.

iv)(a) TEXT BOOKS

1) William H. Hayt., Jr., Jack E. Kemmerly, Steven M. Durbin., *Engineering Circuit Analysis*, McGraw-Hill, 8th Edition, 2012.
2) Kothari D. P. and Nagrath I. J., *Basic Electrical Engineering*, Tata McGraw Hill, 2010.
3) Fitzgerald A.E., David Higginbotham E., Arvin Grabel, *Basic Electrical Engineering*, Tata McGraw Hill, 5th Edition,2009.
4) Boylested, R. L. and Nashelsky, L., *Electronic Devices and Circuit Theory*, Pearson Education, 10thEdition, 2009.
5) Wayne Tomasi and Neil Storey, *A Textbook on Basic Communication and Information Engineering*, Pearson, 5thEdition, 2010.

(b) REFERENCES

1) Paul Breeze, *Power Generation Technologies,* Newnes,3rd Edition, 2019.
2) Allan Hambley R., *Electrical Engineering: Principles & Applications*, Pearson Education,7th Edition, 2018.
3) Mittle V. N. and Arvind Mittal, *Basic Electrical Engineering*, McGraw Hill, 2nd Edition, 2006.
4) N.N. Bhargava , D.C. Kulshreshtha , S.C. Gupta, *Basic Electronics and Linear Circuits*, Tata McGraw - Hill Education, New Delhi, 2nd Edition, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**DC circuits:** Review of Elementary concepts of DC circuits, Current and Voltage Division Rules, Star-delta conversion (resistive networks only-derivation not required), Numerical problems.	**9**
	Analysis of DC circuits: Mesh current method, Node voltage method. Solution of network equations by matrix method, Numerical problems.	
	Magnetic Circuits: Review of Magnetic Circuits, Series magnetic circuits with composite materials, Numerical problems.	
II	**Electromagnetic Induction:** Faraday's laws, Lenz's law, statically induced and dynamically induced emfs, Self-inductance and mutual inductance, coefficient of coupling (derivation not required), Numerical Problems.	**9**
	Alternating Current fundamentals: Generation of alternating voltages, Basic definitions, Average and RMS values of sinusoidal waveforms, Numerical Problems.	

	Power Generating Stations: Solar, Wind, Hydro-electric and Nuclear power stations, Basic concepts with block diagrams only.	
III	**Analysis of AC Circuits:** Transient Analysis of RL circuit, Steady state Analysis of RL circuit, Phasor representation of sinusoidal quantities, Complex forms. **Analysis of simple AC circuits:** Purely resistive, inductive and capacitive circuits; Analysis of RL, RC and RLC series circuits, active, reactive and apparent power. Illustrations using simple example.	**12**
	Three phase AC systems: Generation of three phase voltages, advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents, Power in three phase circuit, Numerical problems.	
IV	**Introduction to Semiconductor devices**	
	Evolution of electronics – Vacuum tubes to nano electronics (In evolutional perspective only)	**1**
	Resistors, Capacitors and Inductors: types, specifications, standard values, colour coding (No constructional features)	**2**
	PN Junction diode: Principle of operation, V-I characteristics, principle of avalanche breakdown and Zener breakdown	**2**
	Bipolar Junction Transistors: PNP and NPN structures, principle of operation, relation between current gains in CE, CB and CC Configurations, input and output characteristics of common emitter configuration.	**5**
V	**Basic electronic circuits and instrumentation**	
	Rectifiers and Power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator	**3**
	Amplifiers: Concept of voltage divider biasing, circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, block diagram of Public Address system.	**5**
	Electronic Instrumentation: Block diagram of an electronic instrumentation system, functions of various equipment (multimeter, DSO and function generator)	**2**
VI	**Introduction to Communication Systems**	
	Evolution of communication systems: Telegraphy to 5G	**1**

	Radio communication: Principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver. **Principle of antenna:** Radiation from accelerated charge	**5**
	Mobile communication: Basic principles of cellular communications, principle and block diagram of GSM.	**4**
	Total hours	**60**

Suggested Simulation Assignments for Basic Electronics Engineering

(1) Plot V-I characteristics of Si and Ge diodes on a simulator.
(2) Plot Input and Output characteristics of BJT on a simulator.
(3) Implementation of half wave and full wave rectifiers.
(4) Simulation of RC coupled amplifier with the design supplied.
(5) Generation of AM signal.

Note: The simulations can be done on open tools such as Proteus, QUCS, KiCad, GNU Radio or similar software to augment the understanding.

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10A	LIFE SKILLS	MNC	2	0	2	-	2020

i) COURSE OVERVIEW:

This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underlie personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify different skills required in personal and professional life.	Understand
CO 2	Apply well defined techniques to cope with emotions and stress and to provide an awareness of the self.	Apply
CO 3	Apply appropriate thinking tools and techniques for creative problem solving.	Apply
CO 4	Explain the importance of teamwork, team performance and team conflicts.	Understand
CO 5	Explain the basic mechanics of effective communication and demonstrate these through presentations.	Understand

iii) SYLLABUS

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO, Life skills for professionals, personality development, IQ, EQ, and SQ

Self-awareness & Stress Management: Definition and need for self-awareness; Tools and techniques of SA, Stress, reasons and effects, the four A's of stress management, Techniques and Approaches, PATH method and relaxation techniques

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, Leadership Grid & leadership Formulation.

iv) (a) TEXT BOOKS

1) Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, 1st Edition, 2016.
2) Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016

(b) OTHER REFERENCES

1) Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
2) Barun K.Mitra, Personality Development & Soft Skills, Oxford Publishers, 3rd impression, 2017.
3) Caruso, D. R. and Salovey P, The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership, John Wiley & Sons,2004.
4) Larry James, The First Book of Life Skills; 1stEdition, Embassy Books, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Life Skills**: Meaning and significance of life skills **Life skills identified by WHO**: Self- awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. **Life skills for professionals:** positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ, EQ, and SQ	**6**
II	**Self-awareness**: Definition, need for self-awareness; Coping With Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback. **Stress Management**: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion-oriented, acceptance-oriented, resilience, Gratitude Training, Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques. **Morals, Values and Ethics**: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Co-operation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.	**6**
III	**21st century skills**: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.	**6**

	Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking Thinking Hats, Mind Map.	
IV	**Group and Team Dynamics:** Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.	**6**
V	Leadership: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.	**6**
	Total hours	**30**

Life skills- Practical part

1. Activities based on Creative thinking tools- 3 hours
2. Case studies on Morals and Ethics- 3 hours
3. Problem solving using Mind map/Six Thinking Hats- 3 hours
4. Group Discussion: Differences between group discussion and debate; Ensuring success in group discussions. - 3 hours
5. Oral presentation and public speaking skills; business presentations - 3 hours

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	2 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Regular Assessment Test	:	15 marks
Continuous Assessment Test (One test only, should include first three modules)	:	25 marks

viii) CONTINUOUS ASSESSMENT PATTERN

Group Discussion (Marks: 9)

Create groups of about 6 students each and engage them on a GD on a suitable topicfor about 20 minutes. Parameters to be used for evaluation are as follows:

- Communication Skills : 3 marks
- Subject Clarity : 2marks
- Group Dynamics : 2 marks
- Behaviours & Mannerisms : 2 marks

Presentation Skills (Marks: 6)

Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation are as follows:

- Communication Skills : 2 marks
- Platform skills : 2 marks
- Subject Clarity/Knowledge : 2 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U18A	ENGINEERING PHYSICS LAB	BSC	0	0	2	1	2020

i) COURSE OVERVIEW:

The aim of this course is to enable the students to gain practical knowledge in Physics to correlate with the theoretical studies. It equips the students to utilize the acquired skills in an appropriate way to explore the prospects of modern technology. It brings more confidence in students and develop the ability to fabricate engineering and technical tools.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Determine the frequency of tuning fork using a Melde's string apparatus by setting up wave pattern in a stretched string.	Understand
CO 2	Examine wave patterns using CRO to measure basic physical quantities viz. frequency and amplitude.	Remember
CO 3	Determine the wavelength of a monochromatic beam of light and thickness of thin wire using principle of interference	Apply
CO 4	Demonstrate diffraction of light using plane transmission grating.	Understand
CO 5	Draw the I-V characteristics of non ohmic devices.	Remember

iii) LIST OF EXPERIMENTS

1) Melde's string apparatus- Measurement of frequency in the transverse mode.
2) Wavelength measurement of a monochromatic source of light using Newton's Rings method.
3) Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.
4) Measurement of wavelength of a source of light using grating.
5) Determination of dispersive power and resolving power of a plane transmission grating.
6) Determination of the wavelength of any standard laser using diffraction grating
7) I-V characteristics of solar cell.
8) CRO-Measurement of frequency and amplitude of wave forms.

iv) REFERENCES

1) S.L. Gupta and V. Kumar, *Practical physics with viva voce*, Pragati Prakashan Publishers, Revised Edition, 2009.
2) M.N. Avadhanulu, A.A. Dani and Pokely P.M., *Experiments in Engineering Physics*, S. Chand &Co, 2008.
3) S. K. Gupta, *Engineering Physics practicals*, Krishna Prakashan Pvt. Ltd., 2014
4) P. R. Sasikumar, *Practical Physics*, PHI Ltd., 2011.

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration (internal)
100	100	-	1 hour

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/Assessment/Viva voce	:	50 marks
End Semester Examination (internally by college)	:	30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18B	ELECTRICAL AND ELECTRONICS WORKSHOP	ESC	0	0	2	1	2020

i) COURSE OVERVIEW:

- To expose the students to the commonly used accessories and components in electrical installations and to provide hands on experience of wiring of electrical circuits.
- To enable the students to familiarize, identify, construct, and debug the electronic components, devices and circuits. It also enables the students engineering skills by soldering practices of electronic circuits.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify electrical accessories, protective elements and their standard symbols and the tools used for electrical wiring.	Remember
CO 2	Develop the connection diagram, identify the suitable accessories and materials necessary for wiring simple lighting circuits for domestic buildings.	Apply
CO 3	Identify different types of batteries and different types of earthing.	Remember
CO 4	Explain the working and purpose of fuse, MCB, ELCB etc. and solar powered circuit.	Understand
CO 5	Identify and test various electronic components.	Understand
CO 6	Draw circuit schematics with EDA tools.	Apply
CO 7	Assemble and test electronic circuits on boards.	Apply

iii) LIST OF EXPERIMENTS

PART I
ELECTRICAL WORKSHOP
List of exercises/experiments

1 **Familiarization/Identification of electrical components with specification (Functionality, type, size, colour coding, symbol, cost etc. of Wires, Cables, Connectors, Fuses, MCB, ELCB, Switches and other electrical installation equipment with ratings).**
2 Wiring of one lamp controlled by one SPST switch and a plug socket (PVC conduit wiring).
3 Wiring of light/fan circuit controlled by two SPDT switches (Staircase wiring).
4 Wiring of a light circuit and a power circuit for domestic applications.
5 Wiring of simple solar chargeable circuit and determination of its characteristics.

6 Demonstration of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.

7 Understand the safety precautions to be observed in the workshop and learn about safety procedures of first aid in case of electrical hazards.

8 Video demonstration of Pipe and Plate Earthing Schemes.

PART II
ELECTRONICS WORKSHOP
List of Exercises / Experiments

1 Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. (Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.))

2 Drawing of electronic circuit diagrams using standard symbols and introduction to EDA tools, Interpret data sheets of discrete components and IC's, Estimation and costing.

3 Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, DSO etc.] [Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de- soldering station etc.]

4 Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using multimeter]

5 Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general-purpose PCB, Crimping.]

6 Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design (using Proteus) and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]

7 Assembling of electronic circuit/system on general purpose PCB, test and show the functioning

- **a.** Fixed voltage power supply with transformer, rectifier diode, capacitor filter, Zener/IC regulator
- **b.** Square wave generation using IC 555 timer in IC base.

iv) REFERENCES

1) Singh R. P., Electrical Workshop: Safety, Commissioning, Maintenance & Testing of Electrical Equipment, Dream tech Press, 3rd Edition, 2019.
2) John H. Watt, Terrell Croft American Electricians' Handbook: A Reference Book for the Practical Electrical Manual, McGraw-Hill, 9th Edition, 2002.
3) Navas K A, Electronics Lab Manual, Volume 1, PHI Learning Private Limited, 5th Edition, 2015**.**

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration (internal)
100	100	-	1 hour

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/Assessment/Viva voce	:	50 marks
End Semester Examination (internally by college)	:	30 marks

SEMESTER – II

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U10B	VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW:

The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include the Calculus of vector valued functions, ordinary differential equations and basic transforms such as Laplace and Fourier Transforms which are invaluable for any engineer’s mathematical tool box. The topics treated in this course have applications in all branches of engineering.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Compute the derivatives and line integrals of vector functions	Evaluate
CO 2	Evaluate surface and volume integrals to solve engineering problems	Evaluate
CO 3	Solve linear ordinary differential equations.	Apply
CO 4	Apply Laplace transform to solve ODEs in engineering	Apply
CO 5	Apply Fourier transforms of functions to solve engineering problems	Apply

iii) SYLLABUS

Vector Calculus – Derivative of vector function, Gradient, Divergence, Curl, Line integral, conservative fields, Green's theorem, surface integral, Gauss divergence theorem, Stokes' theorem.

Ordinary Differential Equations – Homogeneous and Non-Homogeneous linear differential Equations, Euler-Cauchy equations. Method of undetermined coefficients and Method of variation of parameters.

Laplace transforms – Laplace Transform and its inverse, shifting theorems, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function. Dirac delta function. Convolution theorem and its applications

Fourier Transforms – Fourier integral representation, Fourier sine and cosine integrals. Fourier transform and inverse Fourier transform. Fourier sine and cosine transforms, inverse sine and cosine transform. Convolution theorem

iv)(a) TEXT BOOKS

1) H. Anton, I. Biven S. Davis, "Calculus", Wiley, 10th Edition, 2015.
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

(b) REFERENCES

1) George F Simmons: Differential Equation with Applications and its historical Notes, 2nd Edition McGraw Hill Education India 2002.
2) K B Datta, Mathematical Methods for Science and Engineering, Cengage Learning India,1st Edition, 2012.
3) H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th Edition, 2015.
4) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	Calculus of vector functions: Vector valued function of single variable, derivative of vector function and geometrical interpretation, motion along a curve-velocity, speed and acceleration. Concept of scalar and vector fields, Gradient and its properties, directional derivative, divergence and curl, Line integrals of vector fields, work as line integral, Conservative vector fields, independence of path and potential function (results without proof).	12
II	Vector integral theorems: Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals and finding areas. Surface integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z) , Flux integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z), divergence theorem (without proof) and its applications to finding flux integrals, Stokes' theorem (without proof) and its applications to finding line integrals of vector fields and work done.	12
III	Ordinary differential equations: Homogenous linear differential equation of second order, superposition principle, general solution, homogenous linear ODEs with constant coefficients-general solution. Solution of Euler-Cauchy equations (second order only). Existence and uniqueness (without proof). Non homogenous linear ODEs-general solution, solution by the method of undetermined coefficients (for the right-hand side of the form xn, e^{kx}, $sinax$, $cosax$, $e^{kx}sinax$, $e^{kx}\cos ax$ and their linear combinations), methods of variation of parameters. Solution of higher order equations-	12

	homogeneous and non-homogeneous with constant coefficient using method of undetermined coefficient.	
IV	Laplace transforms: Laplace Transform and its inverse, Existence theorem (without proof), linearity, Laplace transform of basic functions, first shifting theorem, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function, Second shifting theorems. Dirac delta function and its Laplace transform, Solution of ordinary differential equation involving unit step function and Dirac delta functions. Convolution theorem (without proof) and its application to finding inverse Laplace transform of products of functions.	**12**
V	Fourier Transforms: Fourier integral representation, Fourier sine and cosine integrals. Fourier sine and cosine transforms, inverse sine and cosine transform. Fourier transform and inverse Fourier transform, basic properties. The Fourier transform of derivatives. Convolution theorem (without proof).	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U10A	ENGINEERING CHEMISTRY	BSC	3	1	0	4	2020

i) COURSE OVERVIEW: The aim of the engineering chemistry program is to expose the students to basic concepts of chemistry and its industrial as well as engineering applications. It also let the students to familiarize with different topics such as new-generation engineering materials, storage-devices, different instrumental methods etc.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basic concepts of electrochemistry and corrosion to explore its industrial functions in various engineering fields.	Understand
CO 2	Explain the various spectroscopic techniques like UV-Visible, IR, NMR and its applications.	Understand
CO 3	Apply the knowledge of analytical method for characterizing a chemical mixture or a compound. Understand the basic concept of SEM for surface characterisation of nanomaterials.	Apply
CO 4	Apply the knowledge of conducting polymers, isomerism and advanced polymers in engineering.	Apply
CO 5	Explain various types of water treatment methods used in industry and domestic purposes.	Understand

iii) SYLLABUS

Electrochemistry – Cell prototypes, Nernst equation and its uses, different types of cells and applications of electrochemical series. Fundamentals of corrosion and its prevention.

Basics of Spectroscopy – Principles and applications of UV-Vis, IR and NMR spectroscopy, instrumentation of UV-Vis spectroscope, colorimetry, MRI technique.

Instrumental methods in chemistry and Engineering materials – TGA, DTA, and chromatography techniques; Basics of polymer chemistry, BS, ABS and Kevlar and conducting polymers, Classifications of nanomaterials, synthesis, SEM, CNT, graphene.

Stereochemistry and polymer chemistry– Different types of isomers with examples; Notations; Conformational analysis, Types of polymers, ABS, Kevlar and applications. Polyaniline and Polypyrrole - preparation properties and applications, OLED.

Water Technology–Types of hardwater and its elimination, DO, BOD and COD and its significance, disinfection of water, reverse osmosis, sewage water treatment.

iv) (a) TEXT BOOKS

1) D. Harvey, N. Rutledge, Industrial Chemistry, ETP, 1stedition, 2018. ISBN: 9781788820554

2) P. W. Atkins, J de Paula, Atkins' Physical Chemistry, Oxford University Press, 11th edition 2014. ISBN: 9780199697403

3) M. Arif, A. Fernandez, K. P. Nair, Engineering Chemistry, first edition, Owl Books,2015.

4) S. Chawla, A text book of Engineering Chemistry, second edition, Dhanpat Rai & Co. 2013.

(b) OTHER REFERENCES

1) C. N. Banwell, E. M. Mc Cash, Fundamentals of Molecular Spectroscopy, McGraw-Hill, 4th edition, 2001. ISBN: 9780074620250

2) H. H. Willard, L. L. Merritt, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 2005. ISBN: 9788123909431

3) A. J. Peacock, A. Calhoun, C. Hanser, Polymer Chemistry: Properties and Application, Verlag GmbH & Company KG, 2012. ISBN: 9783446433434

4) C. Binns, Introduction to Nanoscience and Nanotechnology, Wiley, 2010. ISBN:9780471776475

v) COURSE PLAN

Module	Contents	No. of hours
I	**Electrochemistry and corrosion:** Introduction - Differences between electrolytic and electrochemical cells- Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes- SHE - Calomel electrode - Glass Electrode – Construction and Working. Single electrode potential – definition - Helmholtz electrical double layer - Determination of E^0 using calomel electrode. Determination of pH using glass electrode. Electrochemical series and its applications. Free energy and EMF - Nernst Equation – Derivation - single electrode and cell (Numericals) –Application-Variation of EMF with temperature. Potentiometric titration - Introduction -Redox titration only. Lithium ion cell - construction and working. Conductivity- Measurement of conductivity of asolution (Numericals). Corrosion-Electrochemical corrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.	12
II	**Spectroscopic Techniques and applications:** Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions – Energy level diagram of ethane, butadiene, benzene	**12**

	and hexatriene. Instrumentation of UV-Visible spectrometer and applications. IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and - Determination of force constant of diatomic molecule (Numericals) –Applications. 1H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting (spectral problems) - coupling constant (definition) - applications of NMR- including MRI (brief).	
III	**Instrumental Methods and Nanomaterials:** Thermal analysis – TGA- Principle, instrumentation (block diagram) and applications – TGA of CaC2O4.H2O and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of CaC2O4.H2O. Chromatographic methods - Basic principles and applications of column and TLC- Retention factor. GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications. Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials – Surface characterisation -SEM – Principle and instrumentation (block diagram).	**12**
IV	**Stereochemistry and Polymer Chemistry**: Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures- Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations). R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples. Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane. Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications. Kevlar-preparation, properties and applications. Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.	**12**

V	**Water Chemistry and Sewage Water Treatment:** Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L - Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Municipal water treatment (brief) - Disinfection methods - chlorination, ozone and UV irradiation. Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals). Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram - Trickling filter and UASB process.	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10A	ENGINEERING MECHANICS	ESC	2	1	0	3	2020

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies while stationary or in motion. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the principles and theorems related to rigid body mechanics.	Understand
CO 2	Describe the components of system of forces acting on the rigid body.	Understand
CO 3	Apply the properties of distributed areas and masses for solving problems involving rigid bodies.	Apply
CO 4	Apply the conditions of equilibrium to various practical problems involving different force systems.	Apply
CO 5	Apply appropriate principles to solve problems in rigid body mechanics.	Apply

iii) SYLLABUS

Statics of rigid bodies: Classification of force systems, Composition and resolution of forces, Resultant and equilibrium equations, Methods of projections, Varignon's Theorem of moments.

Friction: Analysis of single and connected bodies. Parallel coplanar forces, couple. Beam reactions.

Properties of surfaces: Centroid of composite areas, Moment of inertia of areas, Polar moment of inertia, Theorem of Pappus-Guldinus, Forces in space.

Dynamics: D'Alembert's principle, Motion on horizontal and inclined surfaces, Motion of connected bodies. Impulse momentum and work energy relation. Curvilinear translation.

Rotation: Kinematics of rotation. Plane motion of rigid body: Instantaneous centre. Simple harmonic motion: Mechanical vibrations.

iv) (a) TEXTBOOKS

1) Timoshenko, S., Young, D. H., Rao, J. V. and Pati, S., *Engineering Mechanics*, Mc-Graw Hill Publishers, 2017.
2) Beer, F. P. and Johnston, R., *Vector Mechanics for Engineers: Statics and Dynamics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 12thEdition, 2005.

3) Bansal, R. K., *A Textbook of Engineering Mechanics*, Laxmi Publications, 8th Edition, 2016.
4) Sharma, D. P., Hibbeler, R. C. and Shames, I. H., *Engineering Mechanics*, Pearson Publishers, 2011.

(b) REFERENCES

1) Bhavikkatti, S. S., *Engineering Mechanics*, New Age International Publishers, 2016.
2) Merriam, J. L. and Kraige, L. G., *Engineering Mechanics* - Vols. 1 and 2, John Wiley, 7th Edition, 2006.
3) Hibbeler, R. C. and Gupta, A., *Engineering Mechanics*, Vol. I Statics, Vol II Dynamics, Pearson Education, 2009.
4) Shames, I. H., *Engineering Mechanics - Statics and Dynamics*, Prentice Hall of India, 4th Edition, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to engineering mechanics - Introduction on statics and dynamics - Basic principles of statics - Parallelogram law, Equilibrium law - Superposition and transmissibility, Law of action and reaction. Free body diagrams - Degree of freedom-Types of supports and nature of reactions -Exercises for free body diagram preparation - Composition and resolution of forces, Resultant and equilibrium equations. Concurrent coplanar forces - Analysis of concurrent forces - Methods of projections - Methods of moment - Varignon's Theorem of Moments.	9
II	Friction - Sliding friction - Coulomb's laws of friction - Analysis of single bodies - Analysis of connected bodies. Parallel coplanar forces - Couple - Resultant of parallel forces - Centre of parallel forces - Equilibrium of parallel forces - Simple beam subject to concentrated vertical loads. General coplanar force system - Resultant and equilibrium equations.	9
III	Centroid of regular geometrical shapes - Centroid of Composite areas. Moment of inertia- Parallel axis theorem - Perpendicular axis theorem -Polar moment of inertia, Radius of gyration. Mass moment of inertia of ring, cylinder and uniform disc. Theorem of Pappus Guldinus. Introduction to forces in space -Vectorial representation of forces, moments and couples - Resultant and equilibrium equations for concurrent forces in space - Concurrent forces in space.	9

IV	Introduction to dynamics - Rectilinear translation - Equations of kinematics. Introduction to kinetics - Equation of motion - D'Alembert's principle - Motion on horizontal and inclined surfaces - Motion of connected bodies. Curvilinear translation - Projectile motion - Introduction to kinetics - equation of motion. Impulse momentum equation and work energy equation. Moment of momentum and work energy equation (Curvilinear translation).	**9**
V	Rotation - Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis - Rotation under a constant moment. Plane motion of rigid body- Instantaneous centre of rotation (concept only). Introduction to harmonic oscillation - Free vibrations - Simple harmonic motion – Differential equation and solution. Degree of freedom - Examples of single degree of freedom (SDOF) systems - Idealisation of mechanical systems as spring-mass systems (concept only). SDOF spring mass system - Equation of motion -Undamped free vibration response - Concept of natural frequency. Effect of damping on free vibration response (concept only).	**9**
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10C	BASICS OF CIVIL AND MECHANICAL ENGINEERING	ESC	4	0	0	4	2020

i) COURSE OVERVIEW

The goal of this course is to provide an insight on the essentials of Civil and Mechanical Engineering discipline to the students of all branches of Engineering and to provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain different types of buildings, their components, materials, construction techniques and basic infrastructure services.	Understand
CO 2	Describe the importance, objectives and principles of surveying.	Understand
CO 3	Apply the principles of levelling to find the level difference between points.	Apply
CO 4	Summarise the different materials and systems in the context of green buildings.	Understand
CO 5	Analyse thermodynamic cycles and Illustrate the working and features of IC Engines	Apply
CO 6	Explain the basic principles of Refrigeration and Air Conditioning and working of hydraulic machines	Understand
CO 7	Explain the working of power transmission elements, basic manufacturing, metal joining and machining processes	Understand

iii) SYLLABUS

Introduction to Civil Engineering: Relevance and major disciplines of Civil Engineering, Introduction to buildings: Types and different components of buildings, Building rules and regulations, Building area.

Introduction to surveying: Objectives, Principle, Classification, Levelling, Introduction to modern surveying instrument- Total Station.

Construction materials: Bricks, Stones, Sand, Timber, Cement, Cement mortar, Concrete, Steel, Modern construction materials.

Building construction: Foundations, Brick masonry, Roofs and floors, Basic infrastructure services, Green buildings.

Basics of Mechanical Engineering: Fundamental of thermodynamics. Analysis of thermodynamic cycles and working of internal combustion engines.CRDI, MPFI and concept of hybrid vehicles.

Refrigeration and power transmission systems - Analysis of reversed Carnot cycle and vapour compression cycle. Introduction to psychrometry. Layout of unit and central air conditioner.

Description and basic analysis of hydraulic pump and turbine. Working of different power transmission devices.

Manufacturing methods and machine tools - Description of various manufacturing, metal joining process and basic machining operations.

Working of different machines tools and CNC machine. Introduction to CAD/CAM, additive and rapid manufacturing.

iv) (a) TEXT BOOKS

1) Mamlouk, M. S., and Zaniewski, J. P., *Materials for Civil and Construction Engineering*, Pearson Publishers, 4th Edition, 2017.
2) Rangwala, S. C., *Essentials of Civil Engineering*, Charotar Publishing House, 1st Edition, 2012.
3) Clifford, M., Simmons, K. and Shipway, P., *An Introduction to Mechanical Engineering Part I* - CRC Press, 2009.
4) Kumar, P., *Basic Mechanical Engineering*, Pearson India, 2013.

(b) REFERENCES

1) Chen, W. F. and Liew, J. Y. R. (Eds), *The Civil Engineering Handbook*, CRC Press (Taylor and Francis), 2ndEdition, 2002
2) Punmia, B. C., Ashok, K. J. and Arun, K. J., *Surveying*, Vol. I, Laxmi Publications (P) ltd., New Delhi, 17thEdition, 2016
3) *Kerala Municipal Building Rules*, LSGD, Govt. of Kerala, 2019
4) SP 7: 2016*, National Building Code of India*, BIS, New Delhi, 2016.
5) Wylen, G. J. V., Sonntag, R. and Borgnakke, C., *Fundamentals of Classical Thermodynamics*, John Wiley & Sons,2012.
6) Sawhney, G. S., *Fundamentals of Mechanical Engineering*, PHI Learning; 3rd Revised Edition, 2015.

v) COURSE PLAN

Module	Contents	No. of hours
I	**General Introduction to Civil Engineering:** Relevance of Civil Engineering in the overall infrastructure development of the Country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Structural Engineering, Transportation Engineering, Geotechnical Engineering, Water Resources Engineering and Environmental Engineering.	**10**

	Introduction to buildings: Types of buildings, selection of site for buildings, components of a residential building and their functions. **Building rules and regulations:** Relevance of NBC, KBR & CRZ norms (brief discussion only). **Building area:** Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR. **Surveying:** Importance, classification, objectives and principles, instruments used. Levelling- principles, dumpy level, simple levelling, differential levelling- problems. Introduction to modern surveying instruments-Total Station.	
II	**Construction materials:** Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand and timber. **Cement Mortar:** Materials and properties. **Cement concrete:** Constituent materials, properties and types. **Steel:** Steel sections and steel reinforcements, types and uses. **Modern construction materials:** Architectural glass, ceramics, plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre-fabricated building components (brief discussion only).	**10**
III	**Building Construction: Foundations:** Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only). **Brick masonry:** Header and stretcher bond, English bond and Flemish bond. **Roofs and floors:** Functions, types; flooring materials (brief discussion only). **Basic infrastructure services:** MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings. **Green buildings:** Materials, energy systems and water management and environment for green buildings (brief discussion only).	**10**
IV	**Fundamentals of thermodynamics**: Review of basics of thermodynamics- system, surroundings, process, cycle- quasistatic process, laws of thermodynamics. Analysis of thermodynamic cycles: Carnot, Otto, Diesel cycles, Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net-work and efficiency. **IC Engines**: CI, SI, 2- Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines. Efficiencies of IC Engines (Definitions only), Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines.	**10**
V	**Refrigeration**: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity	**10**

	and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners. **Hydraulic machines**: Working principle of Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles) **Power Transmission Devices**: Belt and Chain drives, Gear and Gear trains, Single plate clutches.	
VI	**Manufacturing Process**: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications. Metal Joining Processes: List types of welding, Description with sketches of Arc Welding, Soldering and Brazingand their applications. **Basic Machining Operations**: Turning, Drilling, Milling and Grinding. Lathe, Drilling machine, Milling machine. **Computer Aided Machining**: CNC Machine. Principle of CAD/CAM, Rapid and Additive manufacturing.	**10**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10B	PROFESSIONAL COMMUNICATION	HSC	0	0	2	0	2020

i) COURSE OVERVIEW:

The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators. The course aims to enhance the employability and career Skills of students and orient the students towards grooming as a professional.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Demonstrate effective language skills relevant to Engineering through writing and making presentations.	Create
CO 2	Analyze, interpret and effectively summarize a variety of textual and audio content for specific needs	Analyze
CO 3	Apply appropriate thinking and problem solving techniques to solve new case studies.	Apply
CO 4	Present and analyse a given technical/non-technical topic in a group setting and arrive at generalizations/consensus.	Analyze
CO 5	Create professional and technical documents that are clear and adhering to all the necessary conventions.	Create
CO 6	Manage and apply interviewing skills.	Apply

iii) SYLLABUS

Communication Skills: Introducing yourself and others professionally, elevator pitch, recommendation letter, e-mails, netiquettes, telephone etiquettes, demi-official letters.
Business Communication and Technical writing: Product description, narrating an incident, report writing, agenda and minutes, memo, Asking for information and giving information, explaining processes and products, giving instructions, planning a course of action.
Creative Thinking, Critical Thinking Skills and problem solving: Expressing opinion, GD, Arguing, Reading critical texts (general and academic) and summarizing, listening and responding, Negotiation strategies and decision making skills.
Presentation Skills: Oral Presentation Skills (Proposal presentation), Power point presentation (Projects).
Interviews: CVs and Resumes, Job application, Types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (Skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews.

iv)(a) TEXT BOOKS

1) Meenakshi Raman and Sangeetha Sharma (2018). "Professional Communication", 3rd Edition, Oxford University Press, 2018.
2) Meenakshi Raman and Sangeetha Sharma," Technical Communication: Principles and Practice", 2nd Edition, Oxford University Press, 2011.
3) M. Ashraf Rizvi, "Effective Technical Communication". New Delhi: Tata McGraw Hill Publications, 2007.

(b) OTHER REFERENCES

1) English for Engineers and Technologists (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
2) Stephen E. Lucas, "The Art of Public Speaking", 10th Edition; McGraw Hill Education, 2012.
3) William Strunk Jr. & E.B. White, The Elements of Style, 4th Edition, Pearson, 1999.
4) David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.
5) Goodheart-Willcox, "Professional Communication", 1st Edition , 2017.
6) Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6th edition,2015.
7) The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1stEdition, 2013.
8) Anand Ganguly, "Success in Interview", RPH, 5th Edition, 2016.
9) Raman Sharma, "Technical Communications", Oxford Publication, London, 2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	Use of language in communication: Significance of technical communication Vocabulary Development: technical vocabulary, vocabulary used in formal letters/emails and reports, sequence words, misspelled words, compound words, finding suitable synonyms, paraphrasing, verbal analogies. Language Development: subject-verb agreement, personal passive voice, numerical adjectives, embedded sentences, clauses, conditionals, reported speech, active/passive voice. Technology-based communication: Effective email messages, slide presentations, editing skills using software. Modern day research and study skills: search engines, repositories, forums such as Git Hub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism	**6**
II	Reading, Comprehension, and Summarizing: Reading styles,speed, valuation, critical reading, reading and comprehendingshorter and longer technical articles from journals, newspapers, identifying the various transitions in a text, SQ3R method, PQRST method, speed reading. Comprehension: techniques, understanding textbooks, marking and underlining, Note-taking: recognizing non-verbal cues.	**6**

III	Oral Presentation: Voice modulation, tone, describing a process, Presentation Skills: Oral presentation and public speaking skills, business presentations, Preparation: organizing the material, self-Introduction, introducing the topic, answering questions, individual presentation practice, presenting visuals effectively. Debate and Group Discussions: introduction to Group Discussion (GD), differences between GD and debate; participating GD, understanding GD, brainstorming the topic, questioning and clarifying, GD strategies, activities to improve GD skills	**10**
IV	Listening and Interview Skills Listening: Active and Passive listening, listening: for general content, to fill up information, intensive listening, for specific information, to answer, and to understand. Developing effective listening skills, barriers to effective listening, listening to longer technical talks, listening to classroom lectures, talks on engineering /technology, listening to documentaries and making notes, TED talks. Interview Skills: types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews	**12**
V	Formal writing: Technical Writing: differences between technical and literary style. Letter Writing (formal, informal and semi formal), Job applications, Minute preparation, CV preparation (differences between Bio-Data, CV and Resume), and Reports. Elements of style, Common Errors in Writing: describing a process, use of sequence words, Statements of Purpose, Instructions, Checklists. Analytical and issue-based Essays and Report Writing: basics of report writing; Referencing Style (IEEE Format), structure of a report; types of reports, references, bibliography.	**6**
	Total Hours	**40**

Lab Activities

Written: Letter writing, CV writing, Attending a meeting and Minute Preparation, Vocabulary Building

Spoken: Phonetics, MMFS (Multimedia Feedback System), Mirroring, Elevator Pitch, telephone etiquette, qualities of a good presentation with emphasis on body language and use of visual aids.

Listening: Exercises based on audio materials like radio and podcasts. Listening to Song. practice and exercises.

Reading: Speed Reading, Reading with the help of Audio Visual Aids, Reading Comprehension Skills

Mock interview and Debate/Group Discussion: concepts, types, Do’s and don’ts- intensive practice

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	50	50	2 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Regular Assessment	:	25 marks
Continuous Assessment Test (one test only – includes verbal aptitude for placement and higher studies)	:	15 marks*

* conducted for 50 marks and reduced to 15 marks)

viii) REGULAR ASSESSMENT

Project report presentation and technical presentation through PPT	:	7.5 marks
Listening Test	:	5 marks
Group discussion/mock job interview	:	7.5 marks
Resume submission	:	5 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10E	PROGRAMMING IN C	ESC	2	1	2	4	2020

i) COURSE OVERVIEW:

This course aims to introduce the concepts of structured programming. It covers basic concepts of C programming language including arrays, functions, pointers and files. This course involves a lab component which equips the learner to solve computational problems through programming.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamentals of computer architecture and types of software.	Understand
CO 2	Develop a solution using algorithm/flowchart to a computational problem.	Apply
CO 3	Construct programs with control statements and arrays.	Apply
CO4	Make use of user defined data types or functions to solve computational problems.	Apply
CO5	Develop programs using files and pointers.	Apply

iii) SYLLABUS

Computer architecture & Programming Languages – Basics of Computer architecture, Types of Programming Languages, System Software, Application Software, Introduction to structured programming, Algorithms, Flowcharts and Pseudo-codes

C Programming Language – Data Types, variables, keywords, Constants, Operators and Expressions, Control Flow Statements- Conditional statements, Iterative statements, programs

Arrays and Strings– Multidimensional arrays and matrices, String processing, searching and sorting in 1D array.

Functions – Scope of variable, Pass by reference and value methods, Recursive functions. Strutures and union, Storage Classes

Pointers and Files- File Operations, Sequential access and random access, programs covering pointers and files
Introduction to data structures – Types of data structure, Singly linked list.

iv) (a) TEXT BOOKS

1) Byron Gottfried, Programming with C (Schaum's Outlines Series), 3rd Edition, McGraw Hill Education, 2017
2) H. M. Deitel, P. J. Deitel, C: How to program, 7thEdition, Pearson Education, 2010.
3) Anita Goel, Computer Fundamentals ,1st Edition, Pearson, 2010.
4) Ellis Horowits, Sartaj Sahini, Susan Anderson Freed, Fundamentals of Data Structures in C, 2ndEdition, 2008.

(b) OTHER REFERENCES

1) Brian W. Kernighan and Dennis M. Ritchie, C Programming Language, 2nd Edition, Pearson, 2015.
2) Rajaraman V, PHI, Computer Basics and Programming in C, 1st Edition, 2007.
3) Anita Goel and Ajay Mittal, Computer fundamentals and Programming in C, 1st Edition, 2013.

v) COURSE PLAN

Module	Contents	No. of hours
I	Basics of Computer architecture-Von-Neumann Architecture-Processor, Memory, Input and Output devices. Types of Programming Languages, System Software, Application Software: Compilers, Interpreters, high level and low level languages. Introduction to structured programming, Algorithm, flowcharts and Pseudo-code -Examples	8
II	Basic structure of C program: Character set, Tokens, Identifiers in C, Variables and Data Types, Constants, Console IO Operations, printf and scanf, Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using go to statement, While Loop, DoWhile Loop, For Loop, Break and Continue statements.	9
III	Arrays. Strings-string handling functions. Multidimensional arrays and matrices. Linear search and Bubble Sort in array. String processing: In built string handling functions Simple programs covering arrays and strings	9
IV	Functions: The prototype declaration, Function definition. Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls. Storage Classes. Structure and union in C, Array of structures	8

V	Pointers: Pointer variables. Declaring and dereferencing pointer variables. Accessing arrays through pointers. File Operations: open, close, read, write, append Sequential access and random access to files: In built file handling functions (rewind() ,fseek(), ftell(), feof(), fread(), fwrite()), simple programs covering pointers and files. Introduction to Data Structures: Linear and Non linear data structures, Singly Linked list and its operations.	11
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN:

Attendance : 10 marks

Continuous Assessment Test 1 (Theory for 2 hours) : 20 marks

Continuous Assessment Test 2 (Lab Internal Exam for 2 hours) : 20 marks

C PROGRAMMING LAB (Practical Part of ES0U10E)

1. Familiarization of console I/O and operators in C
   - **i)** Display "Hello World"
   - **ii)** Read two numbers, add them and display their sum
   - **iii)** Read the radius of a circle, calculate its area and display it
   - **iv)** Area of triangle after reading its sides
2. Read 3 integer values and find largest of three numbers.
3. Check whether given year is leap year.
4. Display the grade of a student after reading his mark for a subject. (Use switch)
5. Read a Natural Number and check whether the number is prime or not
6. Read a Natural Number and check whether the number is Armstrong or not
7. Display second largest number after reading n numbers from user. (Without array).
8. Read n integers, store them in an array and find their sum and average
9. Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search
10. Read n integers, store them in an array and sort the elements in the array using Bubble Sort algorithm
11. Write a menu driven program for performing matrix addition, multiplication and finding the transpose. Use functions to (i) read a matrix, (ii) find the sum of two matrices, (iii) find the product of two matrices, (i) find the transpose of a matrix and (v) display a matrix.
12. Display sum of diagonal elements of a matrix
13. Read a string (word), store it in an array and check whether it is a palindrome word or not.
14. Read a string (ending with a $ symbol), store it in an array and count the number of vowels, consonants and spaces in it.
15. Display first n prime numbers using Function.
16. Program to find the sum of digits of a number using recursion
17. Using structure, read and print data of n employees (Name, Employee Id and Salary)
18. Read the marks of three subjects for n students of a class and display their names in the order of rank. (Use array of structure)
19. Input and Print the sum of elements of an array using pointers
20. Create a file and perform the following
    - **i)** Write data to the file
    - **ii)** Read the data in a given file & display the file content on console
    - **iii)** append new data and display on console
21. Open a text input file and count number of characters, words and lines in it; and store the results in an output file.
22. Implementation of Singly Linked List.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U18A	ENGINEERING CHEMISTRY LAB	BSC	0	0	2	1	2020

i) COURSE OVERVIEW:

This course is designed to familiarize with the basic experiments in industrial chemistry and to accustom the students with the handling and analyzing chemicals and standard laboratory equipment.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply different techniques of quantitative chemical analysis to generate basic experimental skills.	Apply
CO 2	Explain the use of spectroscopic techniques for analyzing and interpreting the IR spectra and NMR spectra of some organic compounds.	Understand
CO 3	Use instrumental techniques for chemical analysis.	Apply
CO 4	Organize scientific experiments as a team and analyze the results of such experiments.	Evaluate
CO 5	Create an experiment by themselves and applying them to real world problems and data.	Create

iii) LIST OF EXPERIMENTS

1. Estimation of total hardness of water by EDTA method.
2. Analysis of IR and 1H NMR spectra of organic compounds.
3. Determination of wavelength of absorption maximum and colorimetric estimation of Fe3+ in solution.
4. Determination of molar absorptivity of a compound.
5. Estimation of chloride in water by argentometric method.
6. Calibration of pH meter and determination of pH of a solution.
7. Potentiometric titration: Acid – base titration
8. Estimation of dissolved oxygen in water by Winkler's method.

iv) REFERENCES

1) R. K. Mohapatra, *Engineering Chemistry with Laboratory Experiments*, 2015, 1st edition, PHI Learning, New Delhi.
2) S. C. George, R. Jose, Lab *Manual of Engineering Chemistry*, 2019, 1stedition, S. Chand & Company Pvt Ltd, New Delhi.
3) E. Slowinski, W. C. Wolsey, *Chemical Principles in the Laboratory*, 2008, Cengage

Learning, 11th edition, New Delhi.

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration (internal)
100	100	-	1 hour

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/Assessment/Viva voce	:	50 marks
End Semester Examination (internally by college)	:	30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18A	CIVIL AND MECHANICAL WORKSHOP	ESC	0	0	2	1	2020

i) COURSE OVERVIEW

The course is designed to train the students to identify and manage the tools, materials and methods required to execute basic Civil and Mechanical Engineering activities. Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing and executing a basic Engineering activity.It also enables the student to familiarize various tools, measuring devices, practices and different methods of manufacturing processes employed in industry for fabricating components.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Name different devices and tools used for Civil Engineering measurements.	Remember
CO 2	Explain the use of various techniques and devices used in Civil Engineering measurements.	Understand
CO 3	Choose materials and methods required for basic Civil Engineering activities like field measurements, masonry work and plumbing.	Apply
CO 4	Demonstrate the steps involved in basic Civil Engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing and undertaking simple construction work.	Apply
CO 5	Identify the tools and equipment used in fitting, carpentry, sheet metal, foundry, welding and smithy and various machine tools.	Remember
CO 6	Prepare simple models in fitting, carpentry, sheet metal, foundry, welding and smithy trades.	Apply
CO 7	Apply general safety precautions in different mechanical workshop trades.	Understand

iii) LIST OF EXPERIMENTS

A) CIVIL WORKSHOP

1) Set out a one room building of given plan using tape only method and using tape and cross staff.
2) a) Use screw gauge and vernier calliper to measure the diameter of a steel rod and thickness of a flat bar.
   b) Calculate the area of a built-up space and a small piece of land- Use standard measuring tape and digital distance measuring devices.
3) a) Construct a wall using currently used building blocks such as bricks (1 ½ thick brick wall using English bond), hollow blocks, solid blocks, etc. Use spirit level to assess the tilt of walls.

b) Estimate the number of different types of building blocks required to construct a wall of given dimensions.
c) Transfer the level from one point to another point using a water level.

4) Find the level difference between any two points using dumpy level (differential levelling).

5) a) Introduce the students to plumbing tools, different types of pipes, types of connections, traps, valves, fixtures and sanitary fittings.
b) Study of installation of rain water harvesting system in an educational campus.

6) Introduce students to the principle and working of Total Station.

7) Demonstration of a simple construction work using concrete.

B) MECHANICAL WORKSHOP

1) General: Introduction to workshop practice, Safety precautions, Shop floor ethics, Basic First Aid knowledge, Study of mechanical tools
2) Carpentry: Understanding of carpentry tools and making minimum one model.
3) Foundry: Understanding of foundry tools and making minimum one model.
4) Sheet metal: Understanding of sheet metal working and making minimum one model.
5) Fitting: Understanding of fitting tools and making minimum one model.
6) Welding: Understanding of fitting tools and making minimum one model.
7) Smithy: Understanding of smithy tools and making minimum one model.
8) Machine Tools: Demonstration of various machines like shaping and slotting machine, Milling machine, Grinding Machine, Lathe, Drilling Machine, CNC Machines, Power Tools.
   Demonstration of 3D Printer.

iv) REFERENCES

1) Khanna, P. N., *Indian Practical Civil Engineering Handbook*, Engineers Publishers, 2012.
2) Punmia, B. C., Ashok, K. J. and Arun, K.J., *Surveying*, Vol. I, Laxmi Publications (P) ltd., New Delhi, 17th Edition, 2016.
3) Arora, S. P. and Bindra, S. P., *Building Construction*, Dhanpat Rai Publications,43rd Edition,2019.
4) Rangwala, S. C., *Engineering Materials*, Charotar Publishing House, Anand, 43rdEdition, 2019.
5) Sawhney, G.S., *Mechanical Experiments and Workshop Practice*, Dreamtech Press, 2019.
6) Varun, B., *Engineering Workshop: Civil and Mechanical Engineering Practice*, Notion Press, 1stEdition, 2020.

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration (internal)
100	70	30	1 hour

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/Assessment/Viva voce	:	50 marks
End Semester Examination (internally by college)	:	30 marks

SEMESTER – III

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20A	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW:

This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. The basic theory of functions of a complex variable, residue integration and conformal transformation are discussed.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Solve partial differential equations.	Apply
CO 2	Use appropriate methods to solve one dimensional wave equation and heat equation.	Apply
CO 3	Solve problems using analyticity of complex functions	Apply
CO 4	Find the image of regions under conformal mapping	Apply
CO 5	Find complex integrals using Cauchy's formulas to compute several kinds of integrals.	Apply
CO 6	Find the series expansion of complex functions	Apply

iii) SYLLABUS

Partial differential equations: Formation of partial differential equations, Solutions of a partial differential equations, Linear equations of the first order, Method of separation of variables.

One dimensional wave equation-derivation and solution -One dimensional heat equation, derivation and solution

Complex Differentiation: Analytic functions, Cauchy-Riemann equations, harmonic functions, Conformal mappings- standard mappings, Linear fractional transformation .

Complex integration: Line integrals in the complex plane, Contour integrals, Cauchy integral theorem, Cauchy Integral formula

Taylor's series and Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem, Evaluation of definite integral using residue theorem.

iv) a) TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

b) REFERENCES

1. J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
3. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method, Boundary value problems, Method of separation of variables.	12
II	One dimensional wave equation- vibrations of a stretched string, Derivation. Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D'Alembert's solution of the wave equation One dimensional heat equation, derivation. Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation	13
III	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations-harmonic functions, finding harmonic conjugate-Conformal mappings- mappings of $w = z^2, w = e^z, w = \frac{1}{z}$, $w = sinz$	12
IV	Complex integration, Line integrals in the complex plane, Basic properties, first evaluation method, second evaluation method, use of representation of a path-Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain (without proof). Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function Taylor's series and Maclaurin series.	11
V	Laurent's series (without proof)-zeros of analytic functions, singularities, poles, removable-singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem-Residue integration of real integrals –integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$with no poles on the	12

	real axis. ($\int_A^B f(x)dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus)	
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U20A	MECHANICS OF SOLIDS	PCC	3	1	0	3	2020

i) PRE-REQUISITE: ES0U10A ENGINEERING MECHANICS

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of stress, strain and material behaviour under different loading conditions and provide a firm base for the analysis of structural elements.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Recall the fundamental terms and theorems associated with mechanics of linear elastic deformable bodies.	Remember
CO 2	Explain the behaviour and response of various structural elements under various loading conditions.	Understand
CO 3	Apply the principles of solid mechanics to calculate internal stresses/strains, stress resultants and strain energies in structural elements subjected to axial/transverse loads and bending/twisting moments.	Apply
CO 4	Choose appropriate principles or formula to find the elastic constants of materials making use of the information available.	Apply
CO 5	Perform stress transformations, identify principal planes/ stresses and maximum shear stress at a point in a structural member.	Apply
CO 6	Analyse the given structural member to calculate the safe load or proportion the cross section to carry the load safely.	Analyse

iv) SYLLABUS

Concept of stress and strain – types, Stress – strain relation - Hooke's law. Stress-strain diagram of mild steel. Factor of safety, working stress. Axially loaded bars with uniform cross section–stress, strain and deformation. Deformation of axially loaded bars with varying cross section and bars with varying axial loads. Statically indeterminate systems (number of unknowns restricted to two).

Temperature stress in composite bars. Elastic constants and their relationships. Strain energy – concept. Strain energy due to normal stress. Strain energy in bars carrying axial loads. Instantaneous stress in bars due to gradual, sudden and impact loads. Strain energy due to shear stress. Stresses in thin cylinders and spheres due to internal pressure.

Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Relationship between intensity of load, shear force and bending moment. Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different type of loads. Point of contraflexure.

Theory of simple bending, assumptions and limitations. Calculation of normal stress in beams, moment of resistance. Shear stress in beams. Beams of uniform strength. Strain energy due to bending – calculation of strain energy in beams. Differential equation for calculating the deflection of beams. (Introduction and demonstration only. Students are not expected to solve deflection problems.)

Stresses on inclined sections for uniaxial and biaxial stress fields. Principal stresses and principal planes in 2D problems, maximum shear stress. Strains along principal directions. Mohr's circle of stress for 2D problems.

Short columns – direct and bending stress. Kern of a section. Slender columns – Euler's buckling load, slenderness ratio, limitation of Euler's formula. Rankines formula.

Torsion of circular and hollow circular shafts, Power transmitted by circular shafts and hollow circular shafts. Strain energy due to torsion.

v) (a) TEXT BOOKS

1) Timoshenko, Strength of Materials Vol. I & Vol. II, CBS Publishers & Distributers, New Delhi, 3rd edition, 2004.
2) Shah, H.J., Junnarkar, J. B., Charotar Publishing House Pvt. Ltd., 32nd edition, 2016.
3) Rattan, S. S., Strength of Materials, McGraw Hill Education India, 2nd edition, 2016.
4) Bansal, R. K., Strength of Materials, Laxmi Publications (P) Ltd., 6th edition, 2015.

(b) REFERENCES

1) Gere, J.M., Goodno, B. J., Mechanics of Materials, Cengage Learning, 9th edition, 2016.
2) Popov, E.P., Mechanics of Materials, Prentice Hall India, New Delhi, 2002.
3) Beer, F. P. and Johnston, E. R., Mechanics of Materials, Tata McGraw Hill, New Delhi, 5th edition, 2008.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Review of statics – equilibrium conditions, free body diagrams, centroid, moment of inertia, Concept of stress and strain – types, Stress – strain relation - Hooke's law, Young's modulus of elasticity. Stress-strain diagram of mild steel - proportional limit, yield point, ultimate stress, fracture. True and engineering $\sigma - \varepsilon$ curve, idealized $\sigma - \varepsilon$ curves. Factor of safety, working stress. Axially loaded bars with uniform cross section–stress, strain and deformation. Deformation of axially loaded bars with varying cross section (stepped and varying) and bars with varying axial loads and self-weight. Statically indeterminate systems (number of unknowns restricted to two).	**12**
II	Temperature effects, temperature stress in composite bars. Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear. Lateral strain, Poisson's ratio, volumetric strain. Bulk modulus of elasticity, relationships between elastic constants. Strain energy – concept. Strain energy due to normal stress. Strain energy in bars carrying axial loads. Instantaneous stress in bars due to gradual,	**11**

	sudden and impact loads. Strain energy due to shear stress. Stresses in thin cylinders and spheres due to internal pressure.	
III	Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Relationship between intensity of load, shear force and bending moment. Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams subjected to point load, concentrated moments, uniformly distributed and uniformly varying loads. Point of contraflexure.	**11**
IV	Theory of simple bending, assumptions and limitations. Calculation of normal stress in beams, moment of resistance Shear stress in beams- derivation of equation. Variation of shear stress across the cross section. (Derivation required for rectangular, circular and triangular sections only). Beams of uniform strength. Strain energy due to bending – calculation of strain energy in beams- Cantilever and simply supported beams subjected to point load and uniformly distributed load. Differential equation for calculating the deflection of beams. - Moment-curvature relation. Basic differential equation for calculating the deflection of beams. Simple example to calculate deflection of beams (such as cantilever beam with point load at free end) for demonstration purpose.	**12**
V	Stresses on inclined sections for uniaxial and biaxial stress fields, pure shear. Principal stresses and principal planes in 2D problems, maximum shear stress. Strains along principal directions. Mohr’s circle of stress for 2D problems. Short columns – direct and bending stress. Kern of a section. Slender columns – Euler’s buckling load, slenderness ratio, limitation of Euler’s formula. Rankine’s formula. Torsion of circular and hollow circular shafts - assumptions,derivation of torsion equation. Variation of stress across the cross section. Polar modulus. Power transmitted by circular shafts and hollow circular shafts. Strain energy due to torsion.	**14**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U20B	FLUID MECHANICS AND HYDRAULICS	PCC	3	1	0	4	2020

i) PRE-REQUISITE: ES0U10A ENGINEERING MECHANICS

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamentals of fluid flow and to develop the skill for applying the fluid flow concepts in pipe flow and open channel flow for solving civil engineering problems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the relevant concepts of hydrostatics and hydrodynamics.	Understand
CO 2	Apply the principles of fluid statics to examine the pressure distribution in fluids.	Apply
CO 3	Apply the concept of buoyancy and floatation to examine the stability of bodies under hydrostatic condition.	Apply
CO 4	Solve the various aspects of fluid flow using Bernoulli’s equation.	Apply
CO 5	Calculate the major and minor losses in pipe flow.	Apply
CO 6	Apply the basic principles and laws governing fluid flow through open channels.	Apply

iv) SYLLABUS

Fluid properties, variation of pressure in a fluid, measurement of fluid pressure using piezometers and manometers, U-tube manometers, Forces on immersed planes, Hydrostatic force on curved surfaces, Practical application of total pressure spillway gates.

Buoyant force, Principle of floatation, stability of floating and submerged bodies, metacentre and metacentric height, Methods of describing fluid motion, types of fluid flow, continuity equation.

Bernoulli’s equation, Euler’s equation along a streamline, Venturimeter, Pitot tube and Orificemeter, Hydraulic coefficients of orifices, Computation of major and minor losses in pipes, hydraulic gradient line and total energy line, pipes in series and parallel.

Open channel flow, geometric elements of channel section, uniform flow computations, most economical sections, condition for maximum discharge and maximum velocity through circular channels, Discharge computations using weirs, velocity of approach and end contraction.

Specific energy diagram and discharge diagram, Critical flow and its computation, Dynamic equation of gradually varied flow, Computation of length of water surface profiles by direct step method, Specific force, Rapidly varied flow, Hydraulic jump-conjugate or sequent depths.

v) a) TEXT BOOKS

1) Modi, P. N. and Seth, S. M., *Hydraulics and Fluid Mechanics*, S. B. H. Publishers, 22nd edition, New Delhi, 2019.
2) Streeter, V. L. and Wylie, E. B., *Fluid Mechanics*, McGraw Hill, 7th edition, 2010.
3) Subramanya, K., *Theory and Applications of Fluid Mechanics*, Tata McGraw-Hill, 1993.

b) REFERENCES

1) Bansal, R. K., *A Textbook of Fluid Mechanics and Hydraulic Machines*, Laxmi Publications, 10th edition, 2018.
2) Jain, A. K., *Fluid Mechanics including Hydraulic Machines*, Khanna Publishers, 3rd edition, Delhi, 2016.
3) Arora, K. R., *Fluid Mechanics, Hydraulics and Hydraulic Machines*, Standard Publishers, 9th edition, 2017.
4) Kumar, D. S., *Fluid Mechanics and Fluid Power Engineering*, S. K. Kataria & Sons, 9th edition, New Delhi, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Fluid properties (mass density, specific weight, viscosity, specific gravity), Classification of Fluids (prerequisite no questions from this section) **Fluid statics**-variation of pressure in a fluid, measurement of fluid pressure using piezometers and manometers, U-tube manometers, Forces on immersed plane placed vertical and inclined positions. Hydrostatic force on curved surfaces – Practical application of total pressure on spillway gates.	10
II	**Buoyancy and Floatation**: Buoyant force, Principle of floatation, stability of floating and submerged bodies, metacentre and metacentric height, analytical and experimental determination of metacentric height **Hydrodynamics:** Methods of describing fluid motion, Lagrangian and Eulerian methods, velocity and acceleration, types of fluid flow, description of fluid flow- streamline, pathline and streakline; continuity equation in one, two and three dimensions	10
III	**Fluid kinetics**: Forces considered in describing fluid motion, Derivation of Bernoulli's equation by integration of Euler's	14

	equation along a streamline, kinetic energy correction factor, Applications of Bernoulli's equation- Venturimeter, Pitot tube and Orificemeter; Hydraulic coefficients of orifices and their experimental determination, Discharge through small orifice andlarge rectangular orifices Pipe flow: Computation of major and minor losses in pipes, hydraulic gradient line and total energy line, pipes in series- equivalent pipe, flow through parallel pipes.	
IV	**Open channel flow**: Comparison between pipe flow and open channel flow, velocity distribution in open channels, types of channels, type of flow, geometric elements of channel section, uniform flow computations (Chezy's equation, Kutter's and Manning's formula); Most economical sections – rectangular, triangular and trapezoidal channels, condition for maximum discharge and maximum velocity through circular channels, conveyance and section factor Flow measurement in channels: Notches and weirs – Discharge computations using weirs, velocity of approach and end contraction, discharge equations of rectangular weir, triangular weir, trapezoidal and Cipoletti weir, submerged weir, broad crested weir.	**13**
V	**Specific energy:** specific energy diagram and discharge diagram, Critical flow and its computation. **Gradually varied flow:** Dynamic equation of gradually varied flow- different forms, types and characteristics of water surface profilesin rectangular prismatic channels. Computation of length of water surface profiles by direct step method Specific force, Rapidly varied flow-Hydraulic jump-conjugate or sequent depths, expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels, types, uses and characteristics of hydraulic jump	**13**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U20C	SURVEYING AND GEOMATICS	PCC	4	0	0	4	2020

i) PRE-REQUISITE: ES0U10C BASICS OF CIVIL ENGINEERING

ii) COURSE OVERVIEW

Goal of this course is to impart awareness on the various methods of surveying and its computations. In addition, it also provides a basic knowledge on geospatial data acquisition and its processes.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply various surveying techniques for the preparation of contour maps, computation of area-volume and sketching of mass diagram.	Apply
CO 2	Discuss the fundamental aspects of theodolite survey and apply various triangulation techniques in surveying.	Apply
CO 3	Discuss different methods of traverse surveying and traverse balancing.	Apply
CO 4	Apply the concept of theory of errors in surveying techniques.	Apply
CO 5	Apply the basic knowledge of setting out of different types of curves.	Apply
CO 6	Explain various advanced surveying techniques and geospatial data acquisition systems.	Understand

iv) SYLLABUS

Introduction to Surveying- Principles, Ranging, Bearing of survey lines, Local attraction, Declination, Methods of orientation. Levelling- Principles and methods- Simple, Differential, Reciprocal leveling, Profile levelling and cross sectioning. Digital and Auto Level, Errors in leveling, Contouring.

Area and Volume- Computation of area, Computation of volume- prismoidal and trapezoidal formulae. Mass diagram. Theodolite survey- Measurement of horizontal and vertical angle, Principles of stadia and tangential tacheometry (concepts only). Triangulation- Triangulation figures, Triangulation stations, Inter visibility and height of stations, Satellite Stations and reduction to centre.

Traverse Surveying- Methods of traversing, Checks in closed traverse, Balancing the traverse, Omitted measurements. Theory of Errors- Types, Theory of least squares, Weighting of observations, Most probable value, Computation of indirectly observed quantities- Method of normal equations.

Curve Surveying- Elements of simple and compound curves- Methods of setting out, Elements of Reverse curve, Transition curve, Vertical curve. Total Station- Concept of EDM, Principles and working.

Global Positioning Systems- Components and principles, Satellite ranging, Application of GPS, GPS Surveying methods. Remote Sensing- Electromagnetic spectrum-Energy interactions with atmosphere and earth surface features- Spectral reflectance, Resolution, Multi spectral scanning. Geographical Information System- Components of GIS, GIS operations, Map projections methods, Coordinate systems, Data Types.

v) (a) TEXTBOOKS

1) Schofield, W. and Breach, M., Engineering Surveying, Butterworth-Heinemann, 5th Edition, 2007.
2) Punmia, B. C., Jain and Jain, A. K., Surveying (Vol. I and II), Laxmi Publications (P) Ltd., New Delhi, 16th Edition, 2016.
3) Kenetkar, T. P. and Kulkarni, S. V., Surveying and Levelling, Pune Vidyarthi Griha Prakashan, 2004.
4) Burrough, P., Principles of Geographical Information systems, Oxford University Press, 3rd Edition, 2015.
5) Gopi, S., Sathikumar, R. and Madhu, N., Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education Ltd., 1st Edition, 2006.
6) Andersen, J.M., and Mikhail, E. M., Surveying Theory and Practice, McGraw Hill Education, 7th Edition.

(b) REFERENCES

1) Venkatramaiah, C., Textbook of Surveying, Universities Press (India) Private Limited, 2nd Edition, 2011.
2) Agor, R., A Text book of Advanced Surveying, Khanna Publishers, 2011.
3) Duggal, S. K., Surveying (Vol. I and II), Tata Mc Graw Hill, 2015.
4) Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2nd Edition, 2008.
5) Chang K., Introduction to GIS, Tata McGraw-Hill Publishing Co. Ltd, 8th Edition, 2016.
6) Heywood, I., Cornelius, S. and Carver, S., An Introduction to Geographical Information Systems, Pearson Education Ltd., 2nd Edition, 2003.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Surveying-** Principles, Linear, Angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Local attraction, Declination, Methods of orientation (by compass and by backsighting) **Levelling-** Principles of levelling- Dumpy level, Booking and reducing levels, Methods- Simple, Differential, Reciprocal leveling, Profile levelling and cross sectioning. Digital and Auto Level, Errors in leveling. **Contouring-** Characteristics, Methods, Uses.	**12**

II	**Area and Volume-**Computation of area by offsets to base line and by dividing area into number of triangles, Computation of volume of level section by prismoidal and trapezoidal formulae. **Mass diagram-** Construction, Characteristics and uses. **Theodolite survey-** Instruments, Measurement of horizontal and vertical angle, Principles of stadia and tangential tacheometry (concepts only). **Triangulation-** Triangulation figures, Triangulation stations, Inter visibility and height of stations, Satellite Stations and reduction to centre.	12
III	**Traverse Surveying-** Methods of traversing, Checks in closedtraverse, Traverse computations, Balancing the traverse- Bowditch's rule, Transit rule, Graphical method based on Bowditch's rule, Omitted measurements (a line and an angle only). **Theory of Errors-** Types, Theory of least squares, Weighting of observations, Most probable value, Computation of indirectly observed quantities- Method of normal equations.	12
IV	**Curve Surveying-** Elements of simple and compound curves-Methods of setting out (Angular methods only), Elements of Reverse curve (Introduction only), Transition curve- Length of curve, Elements of transition curve, Vertical curve (Introduction only). **Total Station-**Concept of EDM, Principles and working, Advantages and applications.	12
V	**Global Positioning Systems-**Components and principles, Satellite ranging- Calculating position, Signal structure, Application of GPS, GPS Surveying methods-Static, Rapid static, Kinematic methods- DGPS **Remote Sensing-** Definition, Electromagnetic spectrum- Energy interactions with atmosphere and earth surface features- Spectral reflectance of vegetation, soil and water, Classification of sensors- Active and Passive, Resolution- Spatial, Spectral radiometric and temporal resolution, Multi spectral scanning-Along track and across track scanning. **Geographical Information System- C**omponents of GIS, GIS operations, Map projections methods, Coordinate systems- Geographic and Projected coordinate systems, Data Types- Spatial and attribute data, Raster and vector data representation.	12
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U20A	DESIGN AND ENGINEERING	ESC	2	0	0	2	2020

i) PRE-REQUISITE: Nil. It is generic to all engineering disciplines.

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are expected to apply design thinking in learning, which is very important and relevant for today. The course also focuses on familiarizing the students with the aesthetics, ergonomics and sustainability factors in designs and practice professional ethics while designing.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Demonstrate the different stages involved in design engineering process	Understand
CO 2	Compose a problem statement with design objectives taking into account the customer requirements, design constraints and functionality.	Create
CO 3	Develop innovative solutions to the Design problem through brainstorming and ideation.	Apply
CO 4	Identify the concepts of Biomimicry, Aesthetics and Ergonomic factors in designs to add more value to it.	Apply
CO 5	Model the developed idea using the Design communication tools.	Apply
CO6	Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.	Apply

iv) SYLLABUS

Introduction to engineering design. Generate a design through the Design Process stages.

Design Thinking Approach, Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning.

Ideation in Design Thinking - Brainstorming sessions. Design Engineering Concepts. Application of Biomimicry, Aesthetics and Ergonomics in Design.

Design Communication, Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept.

Value Engineering, Concurrent and Reverse Engineering. Expediency, Economics and Environment in Design Engineering. Design Rights. Ethics in Design.

v) (a) TEXT BOOKS

1) Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, *Engineering Design Process*, Third Edition, Cengage Learning, (1 January 2017)
2) Linda C. Schmidt , George Dieter, *Engineering Design*, McGraw Hill Education; Fourth edition (1 July 2017)
3) Pavan Soni, *Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving,* Penguin Random House India Private Limited, 2020
4) Voland, G., *Engineering by Design*, Pearson India 2014, Second Edition, ISBN 9332535051

(b) OTHER REFERENCES

1) Clive L Dym, *Engineering Design: A Project Based Introduction*, Fourth Edition, John Wiley & Sons, New York 2009.
2) Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business; Revised, Updated ed. edition (5 March 2019)
3) Don Norman , *The Design of Everyday Things*, Basic Books; 2nd edition (5 November 2013)
4) Dominique Forest , *Art of Things: Product Design Since 1945*, Abbeville Press Inc.,U.S.; Special edition (16 October 2014)
5) Javier Abarca, Al Bedard, et al, *Introductory Engineering Design – A Projects-Based Approach*, 3rd ed, Regents of the University of Colorado, 2000.
6) Nigel Cross, Design Thinking: *Understanding How Designers Think and Work*, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
7) Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., *Engineering Design: A Systematic Approach*, Springer 2007, Third Edition, ISBN 978-1-84628-319-2.
8) George Dieter , *Engineering Design: A Materials and Processing Approach*, McGraw-Hill Education / Asia; 3rd edition (16 February 2000).

vi) COURSE PLAN

Module	Contents	No. of hours
I	Design Process: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	3
	Practical Exercise: Need Identification. How to define a Problem Statement. Present an idea using the stages of Design Process.	3

II	Design Thinking Approach: -Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Empathize – User Persona, Day in the Life Technique, identify customer requirements using Morphological Chart and set design objectives. Define - Identifying and formulating a Problem Statement -Fish Bone Diagram	**4**
	Practical Exercise: User Persona Chart. Morphological Chart	**2**
III	Ideate - Brainstorming sessions, and ideation using Random word technique, SCAMPER. Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design.	**4**
	Practical Exercise: Brainstorming, 6-3-5 technique, Random Word Technique	**2**
IV	Design Communication: - Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept. Awareness of Basic tools of Design like – Autodesk, CATIA, MATLAB	**3**
	Practical Exercise: Communicating Designs Graphically.	**4**
V	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. Expediency, Economics and Environment in Design Engineering: - Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design	**3**
	Practical Exercise: Case Studies	**2**
	Total hours	**30**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
NC0U20A	SUSTAINABLE ENGINEERING	MNC	2	0	0	-	2020

i) COURSE OVERVIEW

The objective of this course is to expose the students to the concept of sustainability, the global initiatives towards attaining sustainable development goals and the various sustainable practices. The students should realize the potential of technology in addressing environmental issues and bringing in sustainable solutions.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the relevance and the concept of sustainability and the global initiatives towards attaining sustainable development.	Understand
CO 2	Identify sustainable solutions for different types of environmental pollution problems	Apply
CO 3	Discuss the environmental regulations and standards, various tools for environmental management and clean developmentmechanism.	Apply
CO 4	Explain the concept of circular economy, bio-mimicking and the sustainable framework developed in industrial ecology and industrial symbiosis.	Apply
CO 5	Choose the best practice of nonconventional and sustainable energy depending on the available resources and its utilization.	Apply
CO6	Demonstrate the broad perspective of sustainable practices applicable for energy efficient buildings, green engineering, sustainable cities, sustainable urbanization, and sustainable transport.	Apply

iii) SYLLABUS

Sustainability- need and concept, Technology and Sustainable Development, Sustainable Development Goals.
Environmental Pollution: Natural resources and their pollution, Carbon credits, Zero waste concept and 3 R concepts, Clean Development Mechanism: Carbon Trading and Carbon foot print, legal provisions for environmental protection.
Environmental management standards: ISO 14001:2015 frame work, Life Cycle Analysis, Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.
Resources and its utilisation: Basic concepts of Conventional and non-conventional energy.

Sustainability practices: Sustainable habitat, Green buildings, green materials, Sustainable urbanization.

iv) (a) TEXTBOOKS

1) Bradley, A.S., Adebayo,A.O., Maria, P., *Engineering applications in sustainable design and development*, Cengage learning, 1st Edition, 2015.
2) Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Prentice Hall, 1st Edition, 2011.
3) Purohit, S.S., *Green Technology: An Approach For Sustainable Environment*, Agrobios (India), 1st Edition, 2021.
4) Janine, M.B., *Biomimicry: Innovation Inspired by Nature,* William Morrow Paperbacks, 2002.

(b) REFERENCES

1) Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
2) ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System.

v) COURSE PLAN

Module	**Contents**	**No. of hours**
I	Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).	**6**
II	Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Clean Development Mechanism (CDM): Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.	**6**
III	Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.	**6**
IV	Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.	**6**
V	Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.	**6**
	Total hours	**30**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U28A	CIVIL ENGINEERING PLANNING AND DRAFTING LAB	PCC	0	0	3	1	2020

i) PRE-REQUISITE: ES0U10B ENGINEERING GRAPHICS

ii) COURSE OVERVIEW

The course is designed to introduce the fundamentals of Civil Engineering drawing and understand the principles of planning. The students will be able to learn the drafting of buildings manually and use drafting software such as AutoCAD.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Prepare engineering drawings of different types of buildings and their components.	Apply
CO 2	Prepare site plan and service plan as per the latest building rules.	Apply
CO 3	Develop 3D model of a residential building using relevant modelling software.	Create

iv) SYLLABUS

NOTE: Any 12 experiments out of 15 need to be performed mandatorily. Equal weightage to be given for manual drafting and drafting using computer aided drafting software

1) Draw sectional details and elevation of panelled doors
2) Draw sectional details and elevation of glazed windows and ventilators in wood.
3) Draw sectional details, detailing on fixing arrangement and elevation of steel windows
4) Draw elevation, section and detailing of connection between members, arrangement for fixing at the support for steel roof truss.
5) Draw plan, section and elevation of dog legged staircase.
6) Draw sectional details of a load bearing wall over strip footing, RCC Column over isolated footing and pile footing with pile cap.
7) Draw plan, section and elevation of single storied residential buildings with flat roof.
8) Draw plan, section and elevation of two storied residential building.
9) Draw plan, section and elevation of a community hall having corrugated GI sheet roof.
10) Prepare a site plan and service plan as per latest building rules (KPBR or KMBR)
11) Prepare detailed drawing on building services (for single and two storied buildings only) and on-site wastewater disposal systems like septic tank and soak pit.
12) Draw plan, section and elevation of multi-storied framed buildings.
13) Draw plan, section and elevation of a public buildings–office complex, public health centre, post office, bank etc.
14) Draw plan, section and elevation of a industrial building with corrugated GI steel roof and PEB based walling elements.

15) Create 3D model of a two storied residential building and render the model.

v) REFERENCES

1) Shah, M.G., Kale, C. M. and Patki, S. Y. *Building Drawing With An Intergrated Approach to Built Environment*, Tata McGraw Hill Publishing Company Limited, New Delhi, 2002.
2) Dr. Balagopal, T. S. Prabhu, *Building Drawing and Detailing*, Spades Publishers, Calicut, 1987.
3) National Building Code of India
4) Kerala Panchayat building rules, 2019
5) Kerala Municipality building rules, 2019
6) AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA

vi) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
I	Draw sectional details and elevation of panelled doors	3
II	Draw sectional details and elevation of glazed windows and ventilators in wood.	3
	Draw sectional details, detailing on fixing arrangement and elevation of steel windows	
III	Draw elevation, section and detailing of connection between members, arrangement for fixing at the support for steel roof truss.	3
IV	Draw plan, section and elevation of dog legged staircase.	3
V	Draw sectional details of a load bearing wall over strip footing, RCC Column over isolated footing and pile footing with pile cap.	3
VI	Draw plan, section and elevation of single storied residential buildings with flat roof.	3
VII	Draw plan, section and elevation of two storied residential building.	3
VIII	Draw plan, section and elevation of a community hall having corrugated GI sheet roof.	3
	Draw plan, section and elevation of a industrial building with corrugated GI steel roof and PEB based walling elements.	
IX	Prepare a site plan and service plan as per latest building rules (KPBR or KMBR)	3
X	Prepare detailed drawing on building services (for single and two storied buildings only) and on-site wastewater disposal systems like septic tank and soak pit.	3
XI	Draw plan, section and elevation of multi-storied framed buildings.	6

	Draw plan, section and elevation of a public buildings–office complex, public health centre, post office, bank etc.	
XII	Create 3D model of a two storied residential building and render the model.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Marks for 12 exercises using manual drafting in A4 Paper	:	50 marks
Marks for 12 exercises using computer aided drafting software in A3/A4 paper	:	25 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U28B	SURVEY LAB	PCC	0	0	3	2	2020

i) COURSE OVERVIEW

Objective of the course is to impart practical experience to students by exposing them to various techniques of field surveying. The course is designed to make student familiar with conventional and advanced surveying instruments.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Use conventional surveying tools such as chain/tape and compass for plotting and area determination.	Apply
CO 2	Apply levelling principles in field.	Apply
CO 3	Solve triangulation problems using Theodolite.	Apply
CO 4	Compute heights, distances, area and volume using Total Station.	Apply
CO 5	Demonstrate the use of distomat and handheld GPS.	Apply

iii) SYLLABUS

1) Introduction to conventional surveying- Chain Surveying and Compass Surveying.
2) Application of levelling principles in field- Simple Levelling, Differential Levelling, Fly Levelling and Contouring.
3) Distance and Level Difference between accessible points using Theodolite.
4) Distance and Level Difference between inaccessible points using Theodolite.
5) Computation of height of a building using Theodolite.
6) Distance and Level Difference using Tangential Tacheometry.
7) Computation of heights and distances using Total Station.
8) Computation of area using Total Station.
9) Contouring using Total Station.
10) Demonstration of Distomat and handheld GPS.

iv) REFERENCES

1) Schofield, W. and Breach, M., *Engineering Surveying*, Butterworth-Heinemann , 6th Edition, 2007.
2) Punmia, B. C., Jain and Jain, A.K., *Surveying (Vol. I and II)*, Laxmi Publications (P) Ltd., New Delhi, 16th Edition, 2016.
3) Venkatramaiah, C., *Textbook of Surveying*, Universities Press (India) Private Limited, 2nd Edition, 2011.
4) Agor, R., *A Text book of Advanced Surveying*, Khanna Publishers, 2011.

v) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
I	Computation of area using Chain Surveying and Compass Surveying.	**3**
II	Determination of elevation of points on ground by:	
	a) Simple Levelling	**3**
	b) Differential Levelling	**3**
	c) Fly levelling	**3**
	d) Contouring	**3**
III	Distance and Level Difference between accessible points using Theodolite.	**6**
IV	Distance and Level Difference between inaccessible points using Theodolite.	**6**
V	Computation of height of a building using Theodolite.	**3**
VI	Distance and Level Difference using Tangential Tacheometry.	**3**
VII	Computation of heights and distances using Total Station	**3**
VIII	Computation of area using Total Station.	**3**
IX	Contouring using Total Station.	**3**
X	Demonstration of Distomat and handheld GPS.	**3**
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

SEMESTER – IV

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20D	PROBABILITY, STATISTICS AND NUMERICAL METHODS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW:

This course introduces students to the modern theory of probability and statistics, covering important models of random variables and techniques of parameter estimation and hypothesis testing. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals, solving systems of linear equations, and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify the different discrete random experiments and find the probabilities of their occurrence	Apply
CO 2	Identify the different continuous random experiments and find the probabilities of their occurrence	Apply
CO 3	Use statistical inference to draw conclusions concerning characteristics of a population based on attributes of samples drawn from the population	Apply
CO 4	Find roots of equations, definite integrals and interpolating polynomial on given numerical data using standard numerical techniques	Apply
CO 5	Apply standard numerical techniques for solving systems of equations, ordinary differential equations and for fitting curves on given numerical data	Apply

iii) SYLLABUS

Discrete random variables and their probability distributions, Binomial distribution, Poisson distribution, Discrete bivariate distributions, Expectation -multiple random variables.
Continuous random variables and their probability distributions-Uniform, exponential and normal distributions, Continuous bivariate distributions, Expectation-multiple random variables, i.i.d random variables and Central limit theorem.
Population and samples, Sampling distribution of the mean and proportion. Test of hypotheses Concerning mean and proportion. Confidence interval.
Roots of equations- Newton-Raphson, regula falsi methods. Interpolation-finite differences, Newton's forward and backward formula, Newton's divided difference method, Lagrange's method. Numerical integration.
Solution of linear Systems-Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams- Moulton predictor-correction method.

iv) a) TEXT BOOKS

1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage, 2012
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, JohnWiley & Sons, 2016.

b) REFERENCES

1) Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2) Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
3) T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
4) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

(v) COURSE PLAN

Module	Contents	No. of hours
I	Discrete random variables and probability distributions, expected value, mean and variance (discrete) Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial-Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	12
II	Continuous random variables and probability distributions, expected value, mean and variance (continuous)-Uniform, exponential and normal distributions, mean and variance of these distributions Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	12
III	Population and samples, Sampling distribution of single mean and single proportion (large samples) Confidence interval for single mean and single proportions (large samples) Hypothesis testing basics, large sample test for single mean and single proportion Large sample test for equality of means and equality of proportions of two populations-t-distribution and small sample t-test for single mean and pooled t-test for equality of means	12
IV	Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Numerical integration -Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	12
V	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares -Solution of ODE-Euler and	

	Classical Runge - Kutta methods of second and fourth order- Adams-Moulton predictor-corrector methods	12
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U20D	ENGINEERING GEOLOGY	PCC	3	0	1	4	2020

i) COURSE OVERVIEW:

After the completion of course, students will be familiar with basics of earth processes, materials, groundwater and geological characteristics relevant to Civil Engineering applications

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Interpret the relevance of geology in Civil Engineering.	Understand
CO 2	Distinguish subsurface processes of the earth.	Analyse
CO 3	Identify the problems created by ground water in construction and its control measures.	Apply
CO 4	Explain the engineering significance of folds, faults and joints.	Understand
CO 5	Classify minerals and rocks.	Understand
CO 6	Examine the impact of geological factors in civil engineering constructions.	Analyse

iii) SYLLABUS

Relevance of Geology in Civil Engineering, Soil erosion and soil conservation measures, Engineering significance of weathering, Landslides, Coastal Processes, Internal Processes of the earth, Seismic zones of India, Hydrogeology, Porosity and permeability, Methods to control groundwater problems, Mineralogy, Petrology, Rock types of Kerala. Structural Geology, engineering significance of folds, faults and joints. Geological part of site investigation for the construction of dams, reservoirs and tunnels.

iv) (a) TEXT BOOKS

1) Duggal, S. K., Pandey, H. K. and Rawat, N., *Engineering Geology*, McGraw-Hill Education, New Delhi, 2014.
2) Gokhale, K. V. G. K., *Principles of Engineering Geology*, B. S. Publications, Hyderabad, 2015.
3) Singh, P., *Engineering and General Geology,* S. K. Kataria and sons, New Delhi, 2014.
4) Gangopadhyay, S., *Engineering Geology*, Oxford University, 2017.

(b) OTHER REFERENCES

1) Todd, D. K. and Mays, L. W., *Groundwater Hydrogeology*, Wiley India Pvt Ltd., 2011.
2) Gokhale, N. W., *Manual of Geological Maps*, CBS Publishers, 2017
3) Gribble, C. D., *Rutleys Elements of Mineralogy*, Springer, 2005.
4) Billings, M. P., *Structural Geology*, Pearson education, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	Relevance of Geology in Civil Engineering, Surface Processes of the earth- a) Weathering of rocks-Types of weathering, Processes of Origin of Products of weathering like sand, clay, laterite and soil, soil profile, Soil erosion and soil conservation measures. Engineering significance of weathering. b) Geological processes by rivers. c) Landslides-types, causes and controlling measures, Coastal Processes-Geological work by waves and currents and coastal protection measures.	13
II	Internal Processes of the earth- a) Earthquakes- Plate Tectonics, Origin of earthquakes, Seismic waves, Rating of earthquakes, types of earthquakes, Seismic zones of India. Basics of seismic safety factor, Interior of the earth as revealed by propagation of seismic waves.	11
III	Hydrogeology-Occurrence of groundwater, aquifers and types of aquifers, confining beds, porosity and vertical distribution of groundwater. Darcy's Law. Permeability/hydraulic conductivity. Problems created by groundwater to civil engineering structures, Methods to control groundwater problems, Electrical resistivity survey for groundwater exploration. Seawater intrusion in Coastal area. Ghyben Herzberg relation.	12
IV	Mineralogy-Physical properties of minerals, physical properties and chemical composition of minerals like quartz, orthoclase, plagioclase, biotite, muscovite, hornblende, augite, hypersthene, calcite, gypsum. Petrology-Igneous, sedimentary and metamorphic rocks, Igneous rocks -Chemical and mineralogical classification and structure. Sedimentary rocks-types based on mode of formation and structures Metamorphic rocks-structures only. Megascopic study of granite, dolerite, basalt, sandstone, limestone, shale, gneiss, marble and charnockite. Rock types of Kerala. Rock cycle	13
V	Structural Geology– Attitude of rocks – Dip and Strike. Brunton compass. Terminology, brief classification and engineering significance of folds, faults and joints. Geological part of site investigation for the construction of dams, reservoirs and tunnels. Toposheet. Structural mapping. Clinometer compass and Brunton compass.	11
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U20E	GEOTECHNICAL ENGINEERING -I	PCC	4	0	0	4	2020

i) PRE-REQUISITE: ES0U10A ENGINEERING MECHANICS

ii) COURSE OVERVIEW

Goal of this course deals with physical and engineering properties of soil, its behaviour under external loads for different site conditions.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamentals of Soil Mechanics.	Understand
CO 2	Calculate various indices and engineering properties of soils.	Understand
CO 3	Interpret permeability, shear strength and compressibility of soil.	Apply
CO 4	Discuss the field compaction methods and its quality control in the field.	Understand
CO 5	Explain the behaviour of soil deformation and predict the rate of settlement of foundations.	Apply

iv) SYLLABUS

Introduction to soil mechanics -Major soil deposits of India. Basic soil properties - Relationship between basic soil properties. Sensitivity – Thixotropic. I.S. classification of soils.
Index properties - Sieve analysis – Stoke's law - Hydrometer analysis – Relative density.
Consistency-Atterberg Limits - Practical Applications. Permeability of soils - Darcy's law – Factors affecting permeability - Practical Applications - Constant head and falling head permeability tests - Average permeability of stratified deposits.

Shear strength of soils- Mohr- Coulomb failure criterion –Relationship between shear parameters and principal stresses. Brief discussion of direct shear test, tri-axial compression test, vane shear test and unconfined compression test.

Compressibility and Consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility - Normally consolidated, under consolidated and over consolidated states - Estimation of pre consolidation pressure. Estimation of magnitude of settlement of normally consolidated clays. Terzaghi's theory of one-dimensional consolidation - average degree of consolidation – Time factor - Coefficient of consolidation.

Stability of finite slopes - Swedish Circle Method- Friction circle method- Factor of safety with respect to cohesion and angle of internal friction - Stability number – Stability charts.

Compaction of soils - Standard Proctor, Modified Proctor, I.S. light & Heavy Compaction Tests – OMC - Zero Air voids line. Control of compaction.

v) (a) TEXTBOOKS

1. Ranjan, G., and Rao, A.S.R., *Basic and Applied Soil Mechanics,* New Age International (P) Limited, New Delhi, 3rdedition, 2016.
2. Venkataramaiah, *Geotechnical Engineering*, Universities Press (India) Limited, Hyderabad, 6th edition 2018.
3. Terzaghi, K., *Theoretical Soil Mechanics*, John Wiley & Sons, 1943.

(b) REFERENCES

1. Bowles, J. E., Physical and Geotechnical Properties of Soils, McGraw-Hill Book Company, 2nd edition,1989.
2. Das, B. M., Principles of Geotechnical Engineering, Cengage Learning Inc, 7th Edition, 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to soil mechanics -Major soil deposits of India. Basic soil properties - Void ratio, porosity, degree of saturation, air content, percentage air voids, moisture content, specific gravity, unit weight - Relationship between basic soil properties. Sensitivity – Thixotropy - numerical problems. I.S. classification of soils.	10
II	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils - Stoke's law - Hydrometer analysis (no derivation required for percentage finer and diameter) - numerical problems-– Relative density. Consistency-Atterberg Limits - Practical Applications - numerical problems. Permeability of soils - Darcy's law – Factors affecting permeability - Practical Applications - Constant head and falling head permeability tests - Average permeability of stratified deposits (no derivation required) - numerical problems.	12
III	Shear strength of soils- Practical Applications - Mohr- Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses- numerical problems – relationship between shear parameters and principal stresses [no derivation required}. Brief discussion of direct shear test, tri-axial compression test, vane shear test and unconfined compression test – Applicability - numerical problems -UU and CD tests [Brief discussion only].	12
IV	Compressibility and Consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume	14

	compressibility – Compression index Practical Applications -Change in void ratio method - Height of solids method - Normally consolidated, under consolidated and over consolidated states - Estimation of pre consolidation pressure. Practical Applications - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation - Practical Applications - Square root of time and logarithm of time fitting methods - Numerical problems	
V	Stability of finite slopes - Toe failure, base failure, slip failure. Swedish Circle Method- Friction circle method- Factor of safety with respect to cohesion and angle of internal friction - Stability number – Stability charts. Compaction of soils - Standard Proctor, Modified Proctor, I.S. light & Heavy Compaction Tests – OMC - Zero Air voids line. Control of compaction - numerical problems	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit
CE1U20F	TRANSPORTATION ENGINEERING	PCC	3	1	0	4

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of Highway, Railway, Airway, Harbour, Tunnel and Traffic engineering. The course includes geometric design of highways and railways, bituminous mix design, design of flexible pavement and airport runway.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply Indian standard specifications and guidelines to design various geometric elements of a highway and railway track.	Apply
CO 2	Design bituminous mixes for flexible pavements using Marshall method after material characterization.	Apply
CO 3	Design flexible pavements as per CBR method and IRC standards.	Apply
CO 4	Design traffic signal for the efficient management of roadway facilities, using data collected from traffic studies.	Apply
CO 5	Explain the various features of docks and harbours and concepts of tunnelling	Understand
CO 6	Apply standard specifications to design an airport runway.	Apply

iii) SYLLABUS

Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads.

Geometric design of highways, Design controls and criteria, Design of highway cross section elements, Sight distance, Design of horizontal alignment, Design of vertical alignment.

Desirable properties and testing of road aggregates and bituminous materials, Introduction to Viscosity Grading and Performance Grading, Introduction to flexible and rigid pavements, Flexible pavement layers and bituminous mix design by Marshall method, Design of flexible pavements by CBR method and IRC 37: 2018, Construction of bituminous pavements.

Introduction to traffic engineering, Traffic characteristics, Design Speed, Traffic Studies and their applications, Types of road intersections, Traffic control devices, Design of isolated signals by Webster's method.

Railway Engineering - Component parts of a railway track - functions, concept of gauges, Coning of wheels, Geometric design of railway track.

Tunnel Engineering - Tunnel sections, Surveying and alignment, transferring centre, grade into tunnel.

Harbours – classification, features, requirements, Break waters - necessity and functions, classification, Docks – Functions and types.

Introduction to Airport Engineering, Components of airport, selection of site for airport, Runway orientation, basic runway length and corrections required.

iv) (a) TEXTBOOKS

1) Khanna, S. K., Justo, E. G. and A Veeraragavan, Highway Engineering, Nem Chand and Bros., 10th edition, 2018.
2) Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers, 2017.
3) Saxena, S. C. and Arora, S. P., A Text Book of Railway Engineering, 7th edition, Dhanpat RaiPublications, 2015.
4) Srinivasan, R., Harbour, Dock & Tunnel Engineering, 28th edition, Charotor Publishing HousePvt. Ltd., 2016.
5) Khanna, S. K., Arora, M. G. and Jain, S. S., Airport Planning and Design, VI Edition,Nemchand & Bros, 2017.

(b) CODES OF PRACTICES

1) IS: 1201 - 1978 to IS: 1220 - 1978 (Reaffirmed 2004) Edition 2.1 (1996-11), Indian StandardMethods for Testing Tar and Bituminous Materials, Bureau of Indian Standards, New Delhi.
2) IS: 73 - 2013 (2013), Indian Standard Paving Bitumen – Specification, Fourth Revision,Bureau of Indian Standards, New Delhi.
3) IRC: 37 - 2018 (2018), Guidelines for the Design of Flexible Pavements, Indian Roads Congress, New Delhi.
4) MS 2: Asphalt Mix Design Methods, 7th Edition, Asphalt Institute, USA, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads Geometric design of highways, Design controls and criteria, Design of highway cross section elements, Stopping sight distance, Intermediate sight distance, Overtaking sight distance, Sight distance at intersection, Design of horizontal alignment, Design of Vertical alignment	14
II	Desirable properties and testing of road aggregates and bituminous materials, Introduction to Viscosity Grading and Performance Grading Flexible and rigid pavements, Factors influencing the design of flexible pavements, Flexible pavement layers and bituminous mix design by Marshall method, Design of flexible pavements by CBR method and **IRC 37: 2018**, Construction of bituminous pavements.	14
III	Introduction to traffic engineering, Traffic characteristics, Design Speed, Traffic Studies and their applications, Types of road	10

	intersections, Traffic control devices, Design of isolated signals by Webster's method.	
IV	Railway Engineering - Component parts of a railway track - Functions, Concept of gauges, Coning of wheels, Geometric design of railway track- horizontal curves, radius, super elevation, cant deficiency, transition curves, gradients, compensation of gradients. Tunnel Engineering: Tunnel sections, tunnel surveying and alignment, transferring centre, grade into tunnel	**12**
V	Harbours – classification, features, requirements. Break waters - necessity and functions, classification Docks – Functions and types - dry docks, wet docks Introduction to Airport Engineering, Components of airport, selection of site for airport, Runway orientation, basic runway length and corrections required.	**10**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U20A	PROFESSIONAL ETHICS	HSC	2	0	0	2	2020

i) COURSE OVERVIEW

To enable students to create awareness on ethics and human values.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Infer the core values that shape the ethical behaviour of a professional.	Understand
CO 2	Apply philosophical concepts discussed in the course to personal and contemporary issues.	Apply
CO 3	Explain the role and responsibility of engineer in technological development without compromising personal ethics and legal ethics.	Understand
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.	Apply
CO 5	Demonstrate the concept of Corporate Social Responsibility, and explore its relevance to ethical business activity	Understand
CO 6	Apply the knowledge of human values and social values to contemporary ethical values and global issues.	Apply

iii) SYLLABUS

Morals, values and Ethics – Integrity- Academic Integrity-Work Ethics- Service Learning-Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- Courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas – Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional Roles-Theories about right action –Self-Interest-Customs and Religion- Uses of Ethical Theories.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics-Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining-Confidentiality- Role of confidentiality in moral Integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership.

iv) a) TEXT BOOKS

1) M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
2) R S Naagarazan, A textbook on professional ethics and human values, New-age International (P) limited, New Delhi, 2006.

b) REFERENCES

1) Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, NewDelhi,2014.
2) Charles D Fledder mann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3) Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4) http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

v) COURSE PLAN

Module	Contents	No. of hours
I	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics Service Learning, Civic Virtue, Respect for others, Living peacefully Caring and Sharing, Honesty, Courage, Co-operation commitment Empathy, Self Confidence, Social Expectations	6
II	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry-Moral dilemmas, Moral Autonomy, Kohlberg's theory Gilligan's theory, Consensus and Controversy, Profession & Professionalism, Models of professional roles, Theories about right action-Self-interest-Customs and Religion, Uses of Ethical Theories	6
III	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law-Challenger case study, Bhopal gas tragedy	6
IV	Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest-Occupational crime, Professionalrights, Employee right, IPR, Discrimination	6
V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership-Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	6
		30

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20B	CONSTITUTION OF INDIA	MNC	2	0	0	---	2020

i) PREAMBLE:

The study of the Constitution of India enables the students to

1) Understand the fundamental rights & duties and directive principles
2) Understand the functions of Executive, Legislature and Judiciary of the Union and the States
3) Understand the relation between the Union and the States
4) Provides the student the knowledge and strength to face the society and people.

ii) PREREQUISITE: Nil

iii) COURSE OUTCOMES:

After the completion of the course, the student will be able to:

CO 1	Explain the historic background of the constitution of India and its features.	Understand
CO 2	Describe the fundamental rights, duties and directive principles of state policy.	Understand
CO 3	Discuss the machinery of executive, legislature and judiciary of the Union and the States.	Understand
CO4	Explain the relation between the Union and the States.	Understand
CO 5	Demonstrate national and patriotic spirit as responsible citizens of the country.	Apply

iv) SYLLABUS

Constitution of India: Definition, historical background, features, preamble, territory, citizenship. State, fundamental rights, directive Principles, fundamental duties. The machinery of the union government, machinery of the state governments. Statutory institutions, miscellaneous provisions, amendments to constitution.

v) a) TEXT BOOKS

1) M. Laxmikanth, Indian Polity, McGraw Hill Education India, 6th edition, 2019.
2) D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi, 24th edition, 2019.
3) P. M. Bhakshi, The Constitution of India, Universal Law, 14th edition, 2017.

b) REFERENCES

1) Ministry of Law and Justice, The Constitution of India, Govt. of India, New Delhi, 2019.
2) J. N. Pandey, The Constitutional Law of India, Central Law agency, Allahabad, 51st edition, 2019.
3) M. V. Pylee, India's Constitution, S. Chand and Company, New Delhi, 16th edition, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition of constitution, historical back ground, salient features of the constitution. Preamble of the constitution, union and its territory. Meaning of citizenship, types, termination of citizenship.	**4**
II	Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation. Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.	**7**
III	The Union Executive, the President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament. Union judiciary, the supreme court, jurisdiction, appeal by special leave.	**7**
IV	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories. The State Legislature, composition, qualification and disqualification of membership, functions. The state judiciary, the high court, jurisdiction, writs jurisdiction.	**6**
V	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals. Official language, elections, special provisions relating to certain classes, amendments to constitution.	**6**
	Total hours	**30**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U28C	MATERIAL TESTING LAB - I	PCC	0	0	3	2	2020

i) PREREQUISITE: Engineering Mechanics, Knowledge in use of Vernier caliper and micrometer screw gauge expected.

ii) COURSE OVERVIEW:
The students will be able to undertake the testing of materials when subjected to different types of loading.

iii) COURSE OUTCOMES
After the completion of the course, the student will be able to:

CO 1	Apply the fundamental modes of loading of structures.	Apply
CO 2	Examine how to measure loads, displacements and strains.	Apply
CO 3	Compare the strength of the material and stiffness properties of different structural elements.	Apply
CO 4	Discover professional and ethical responsibility in the areas of material testing.	Apply
CO 5	Apply techniques, skills and modern engineering tools necessary for engineering.	Apply

iv) SYLLABUS
Study on stress-strain characteristics of mild steel rod and HYSD bars, Estimation of modulus of rigidity of Steel wire, Estimation of modulus of rigidity of mild steel circular bars and Tor steel, Study on flexural behaviour of wooden beam, Estimation of compressive strength of wooden specimen, Estimation of toughness of steel, Estimation of modulus of rigidity of open coiled and closed coiled springs, Estimation of hardness properties of engineering materials, Determination of shear capacity of mild steel specimen, Determination of moment of inertia of fly wheel, Bend and rebend test on mild steel specimen, Verification of Clerk Maxwell's Reciprocal Theorem, Study on flexural behaviour of steel I section, Estimation of modulus of elasticity of Torr steel using strain gauge, Demonstration on strain gauges and load cells.

v) REFERENCES

1) Davis, Troxell and Hawk, Testing of Engineering Materials", International Student Edition, McGraw Hill Book Co. New Delhi, 4th Edition, 2005
2) Gambhir, M, L., and NehaJamwal, Building and construction materials Testing and quality control, McGraw Hill education(India)Pvt. Ltd., 2014
3) Holes,K, A,. Experimental Strength of Materials, English Universities Press Ltd. London,2019
4) Suryanarayana ,A,K., Testing of Metallic Materials, Prentice Hall of India Pvt. Ltd. New Delhi, 2007

5) Kukreja, C, B., Kishore. K., and Chawla, R., Material Testing Laboratory Manual, Standard Publishers & Distributors, 2006.
6) Dally, J, W., Railey, W, P., Experimental Stress analysis, McGarw Hill,2012
7) Baldev, R., Jayakumar, T., and Thavasimuthu M., Practical Non-destructive testing, Narosa Book Distributors,2015
8) Relevant IS Codes

vi) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
I	Tension test on Mild Steel Rod and HYSD bars	3
II	Torsion test on Steel wire	3
III	Torsion test on Mild Steel Rod	3
IV	Bending Test on wooden beams	3
V	Study on estimation of compression strength of timber specimen	3
VI	Impact test a. Izod Apparatus b. Charpy Apparatus	3
VII	Spring test a. Open Coiled Spring b. Closed Coiled Spring	3
VIII	Hardness Test a. Brinell hardness b. Rockwell Hardness	3
IX	Double shear test	
X	Moment of Inertia of Fly wheel	3
XI	Bend and rebend test on mild steel specimen	3
XII	Verification of Clerk Maxwell's Theorem	3
XIII	Bending test on steel I Section	3
XIV	Modulus of Elasticity of Tor Steel Using Strain Gauge	3
XV	Study/Demonstration of strain gauges and load cells.	3
XVI	At the end of the course, students are required to do a term project in group (maximum 6 members) wherein they will be supplied a material in crude form/ unworked form and they are supposed to shape the material in the required form (they can make use of facilities at mechanical workshop) and carry out tests to assess its material properties.	3
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ME0U28A	FLUID MECHANICS LAB	PCC	0	0	3	2	2020

i) COURSE OVERVIEW

Objective of the course is to train the students to familiarize and understand the different flow measurement equipment's and their procedures. Students will be introduced to a team working environment where they develop the necessary skills of experimentation techniques for the study of flow phenomena in channels/pipes.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply fundamental knowledge of Fluid Mechanics to corresponding experiments	Apply
CO 2	Apply theoretical concepts in Fluid Mechanics to respective experiments	Apply
CO 3	Analyse experimental data and interpret the results	Analyze
CO 4	Document the experimentation in prescribed manner	Apply

iii) LIST OF EXPERIMENTS

List of Experiments
Study of taps, valves, pipe fittings, gauges, pitot tubes, water meters and current meters
Determination of metacentric height and radius of gyration of floating bodies
Verification of Bernoulli's theorem
Hydraulic coefficients of orifice under constant head method
Hydraulic coefficients of orifice using time of emptying method
Calibration of venturimeter
Calibration of orifice meter
Calibration of rectangular notch
Calibration of triangular notch
Calibration of trapezoidal notch

Time of emptying through orifice
Determination of friction coefficient in pipes

iv) REFERENCES

1) Yunus A. Cenegel, John M. Cimbala; *Fluid Mechanics- Fundamentals and Applications,*4th edition, McGraw Hill,2019
2) Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, John W. Mitchell *Fluid Mechanics*, John Wiley and sons, 9th Edition, 2016
3) Modi P.N and Seth S.M, *Hydraulics and Fluid Mechanics Including Hydraulic Machines*, Standard Book House, New Delhi, 22nd Edition, 2019

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

SEMESTER – V

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30A	STRUCTURAL ANALYSIS I	PCC	3	1	0	4	2020

i) PRE-REQUISITE: CE1U20A MECHANICS OF SOLIDS

ii) COURSE OVERVIEW:

The course enables the students to analyse various types of simple structures using appropriate methods and tools. It introduces the applications of principles of mechanics of solids to determine stress resultants in statically determinate and indeterminate structures. Specific cases of cables, suspension bridges and arches are also discussed at length. The course trains the students to develop mathematical models and helps to sharpen their analytical skills. After this course students will be able to analyse structures subjected to moving loads as well.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply specific methods such as slope deflection and moment distribution methods of structural analysis for typical structures with different characteristics.
CO 2	Apply method of consistent deformation to solve statically indeterminate structures
CO 3	Analyze the effect of moving loads on beams by the concept of Influence Line Diagrams
CO 4	Analyze statically determinate cables and apply the same in suspension bridges and arch systems
CO 5	Apply force method and displacement method to analyse structures.

iv) SYLLABUS

Statically determinate structures, Elastic theorems and energy principles, Castigliano’s method for deflection, Betti’s theorem – Maxwell’s law of reciprocal deflections. Principle of least work, Concepts of temperature effects and lack of fit, statically indeterminate structures, Method of Consistent deformations. Cables, Suspension Bridges. Arches: Theory of arches – Eddy’s theorem, Moving loads and influence lines. Slope Deflection Method, Moment Distribution Method, Introduction to structural analysis software.

v) (a) TEXT BOOKS

1) Gere and Timoshenko, *Mechanics of materials*, CBS Publishers
2) Leet K, Uang C M & Gilbert A M, Fundamentals of Structural Analysis, McGraw Hill
3) Vaidyanathan R and Perumal P, Comprehensive Structural Analysis Volume I & II, Laxmi Publications (P) Ltd

(b) OTHER REFERENCES

1) Wang C.K., Intermediate Structural Analysis, McGraw Hill
2) Kassimali A, Structural Analysis, Cenage Learning
3) Chandramouli P N, Structural Analysis I –Analysis of Statically Determinate Structures, Yes Dee Publishing Pvt Ltd., Chennai, Tamil Nadu.
4) Menon D, Structural Analysis, Narosa Publications
5) Hibbeler, Structural Analysis, Pearson Education
6) Kinney S., Indeterminate Structural Analysis, Oxford & IBH
7) Gambhir M.L., Fundamentals of structural Mechanics and analysis, Printice Hall India
8) Reddy C.S., Indeterminate Structural Analysis, Tata McGraw Hill
9) Timoshenko S.P. & Young D.H., Theory of Structures, McGraw Hill
10) Schodak D L, Structures, Pearson Education, 7e, 2014
11) Negi L. S. and Jangid R. S, Structural Analysis, Tata McGraw Hill, 1997
12) Rajasekaran S. and Sankarasubramanian G., Computational Structural Mechanics, PHI, 2008
13) Bhavikatti S.S., Structural Analysis II, Vikas Publication Houses (P) Ltd, 2016
14) Utku S, Norris C. H & Wilbur J. B, Elementary Structural Analysis, McGraw Hill, 1990

vi) COURSE PLAN

Module	Contents	No. of hours
I	Statically determinate structures: Trusses: Method of joints and method of sections (Numerical problems). Elastic theorems and energy principles: strain energy due to axial load, bending moment, shear and torsion - strain energy method, Castigliano's method for deflection Derivations only). Betti's theorem – Maxwell's law of reciprocal deflections.	12
II	Principle of least work; Application of unit load method and strain energy method for determination of deflection of statically determinate beams, frames - pin jointed trusses (simple numerical problems). Concepts of temperature effects and lack of fit (No numerical problems). Statically indeterminate structures: Degree of static and kinematic indeterminacies – Introduction to force and displacement Methods. Method of Consistent deformations: Analysis of beams frames and trusses with internal and external redundancy (Simple problems with maximum one redundant – Illustration only for two redundant).	12
III	Method of Consistent deformations (continued): Concepts of effect of prestrain, lack of fit, temperature changes and support settlement. (No numerical problems). Cables: Analysis of forces in cables under concentrated and uniformly distributed loads - Anchor Cable supports.	12

	Suspension Bridges: Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers.	
IV	Arches: Theory of arches – Eddy's theorem - analysis of three hinged arches-Support reactions-normal thrust and radial shear at any section of a parabolic arch due to simple cases of loading. Moving loads and influence lines: Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams and over hanging beams - analysis single concentrated load, several concentrated loads, uniformly distributed load shorter and longer than the span.	**12**
V	Slope Deflection Method: Analysis of continuous beams and portal frames without sway. Frames with sway (illustration only). Settlement effects (derivation only). Moment Distribution Method: Analysis of beams and frames – non sway analysis. Sway analysis (illustration only). Introduction to structural analysis software (hands on exercises on two simple structural analysis problems).	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30B	DESIGN OF CONCRETE STRUCTURES	PCC	3	1	0	4	2020

i) PRE-REQUISITE: CE1U20A MECHANICS OF SOLIDS

ii) COURSE OVERVIEW

Goal of this course is to provide the fundamental concepts in reinforced concrete design and enable students to design and detail reinforced concrete structural members such as beams, slabs, columns and footings. The course also provides an introduction to earthquake resistant design and detailing.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of limit state design and codal provisions for design of concrete members under bending, shear, compression and torsion.	Understand
CO 2	Analyze reinforced concrete sections to determine the ultimate capacity in bending, shear and compression.	Analyze
CO 3	Examine the designs of beams, slab, columns, footings and stairs using IS code provisions and provide the detailing of these structural elements.	Analyze
CO 4	Identify the criteria for earthquake resistant design of structures and ductile detailing of concrete structures subjected to seismic forces.	Apply

iv) SYLLABUS

Introduction – Principles of Limit state method of design, Introduction to BIS code; Types of limit states; Limit State of Collapse by flexure; Analysis and design of singly reinforced rectangular beams, cantilever beam.

Analysis and Design of doubly reinforced beams; T-beams- terminology- Formulae for analysis of T beams; Limit state of collapse in shear and bond - IS code recommendations for shear design, Design of shear reinforcement; Bond and development length; Design for torsion

Design of slabs- introduction- one-way and two-way action of slabs, IS recommendations for design of slabs- one-way slab- concepts of detailing of continuous slab; Two- way slabs- Stair cases- Types - codal provisions – Concepts of tread-riser type stairs, Design and detailing of dog legged stair

Columns- introduction – classification, IS specifications regarding columns- limit state of collapse: compression, Design of axially loaded short columns; short columns subjected to compression and uniaxial bending, short columns subjected to combined axial load and biaxial bending moments - design using SP16 charts for limit state
Foundations- classification - design of isolated footings - detailing Combined footings (design principles only) - analysis of combined footings; Limit state of serviceability - limit state of

deflection, limit state of cracking; Introduction to earthquake resistant design, Importance of Ductility in Seismic Design, Major Design Considerations, Codal provisions

v) a) TEXT BOOKS

1) Punmia, B. C, Jain, A. K. and Jain A. K. , *R. C. C. Designs*, 10th edition, Laxmi Publications Ltd., 2015.
2) Varghese, P. C., *Limit State Design of Reinforced Concrete*, 2nd edition, Prentice Hall of India Pvt Ltd, 2017.
3) Nilson, A. H., Darwin, D. and Dolan, C. W., *Design of Concrete Structures*, 15th edition, Tata Mc-Graw Hill Book Co., New york, 2016.

b) REFERENCES

4) Pillai, S. U. and Menon, D., *Reinforced Concrete Design*, Tata McGraw Hill Book Co., 2015.
5) Varghese, P. C., *Advanced Reinforced Concrete Design*, 2nd edition, Prentice Hall of India Pvt Ltd, 2017.
6) Duggal, S. K., *Earthquake Resistant Design of Structures*, 2nd edition, Oxford University Press, 2013.
7) IS 456: 2000, *Indian Standard Plain and Reinforced Concrete - Code of practice*, 4th revision, Bureau of Indian Standards, New Delhi
8) SP 16: 1980, *Design Aids for Reinforced Concrete to IS 456: 1978*, Bureau of Indian Standards, New Delhi.
9) IS 1893: 2006 Part I, *Indian Standard Criteria for Earthquake Resistant Design of Structures*, Bureau of Indian Standards, New Delhi.
10) IS 13920 : 1993 (Reaffirmed 1998) Edition 1.2 (2002-03), *Indian Standard Ductile Detailing of RCC Structures subjected to seismic forces- Code of practice*, Bureau of Indian Standards, New Delhi

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Principles of Limit state method of design, Introduction to BIS code, Types of limit states - characteristic and design values - partial safety factors - types of loads and their factors. **Limit State of Collapse by flexure:** Assumptions-stress-strain relationship of steel and concrete; Analysis of singly reinforced rectangular beams – balanced, under reinforced, over reinforced sections - moment of resistance codal provisions; Design of singly reinforced rectangular beams - basic rules for design, Design example of simply supported beam, design of cantilever beam -detailing	10
II	**Doubly reinforced beams:** Analysis and design of doubly reinforced beams – detailing.	13

	T-beams: Terminology - Formulae for analysis of T beams – Design examples. **Limit state of collapse in shear and bond:** Shear stresses in beams - types of reinforcement - shear strength of RC beam - IS code recommendations for shear design, Design of shear reinforcement – examples. **Bond and development length:** Anchorage for reinforcement bars - code recommendations regarding curtailment of reinforcement. **Torsion:** Concept, IS code approach, Design examples.	
III	**Design of slabs:** Introduction - one-way and two-way action of slabs - load distribution in a slab - IS recommendations for design of slabs-design of one-way slab- numerical problems – concepts of detailing of continuous slab –code coefficients; Two- way slabs- simply supported, restrained slabs, design using IS Code coefficients Reinforcement detailing. **Stair cases:** Types-proportioning – loads- distribution of loads – codal provisions – Concepts of tread-riser type stairs (detailing only), Design and detailing of dog legged stair	**13**
IV	**Columns:** Introduction – classification - short column, long column –IS specifications regarding columns - Limit state of collapse: compression – Design of axially loaded short columns-design examples with rectangular ties and helical reinforcement. **Design using SP16 charts for limit state:** Analysis and design of short columns subjected to compression and uniaxial bending, biaxial bending moments-code procedure for design.	**12**
V	**Foundations:** Classification - IS code provisions for design of isolated footings - Design principles of rectangular footings- detailing, Combined footings (design principles only)- analysis of combined footings-rectangular and trapezoidal. **Limit state of serviceability:** - Limit state of deflection - short term and long term deflection, IS code recommendations; Limit state of cracking - estimation of crack width- simple numerical examples. **Introduction to earthquake resistant design:** Importance of Ductility in Seismic Design, Major Design Considerations, Codal provisions – IS 1893, IS 13920.	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30C	GEOTECHNICAL ENGINEERING - II	PCC	4	0	0	4	2020

i) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING – I

ii) COURSE OVERVIEW:

To give an endure in the implementation of soil investigation, foundation and settlement concepts which are able to recognize and practice in real-world situations and respond accordingly.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Calculating the lateral earth pressure force against a retaining wall	Apply
CO 2	Explain the basic concepts and theories in foundation engineering	Understand
CO 3	Calculate the load carrying capacity and settlement of shallow and deep foundations	Apply
CO 4	Describe soil exploration and its methods	Understand

iv) SYLLABUS

Earth pressure-types of earth pressures. Rankine's theory and coulomb theory – Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure Earth pressure with layered backfill.

Foundation - General Considerations-Functions of foundations. Selection of type of foundation - Different types of shallow foundations.

Bearing capacity of shallow foundations and settlement analysis -- Failure mechanism - Allowable soil pressure. Terzaghi's bearing capacity theory -Factors affecting bearing capacity - Effect of water table on bearing capacity – types of shear failures- Skempton's formula.

Settlement analysis- causes of settlement – Estimation of immediate and Allowable Settlement-Maximum and differential settlements as per Indian standard - Field test - Plate load test.

Footings: Principles of design of footings – strip/continuous and individual footings Combined footings- Rectangular and Trapezoidal combined footings. Footings subjected to eccentric loading.

Raft foundations: Types – Principles of design of raft foundation- Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula) - Floating foundations - conventional design procedure for rigid mat.

Pile foundations- uses - classification - determination of type and length of piles - Bearing capacity I.S. Static formulae- Dynamic formulae (Modified Hiley formulae only) – I.S. Pile load

test [conventional] - Negative skin friction - Group action - Group efficiency - Capacity of Pile groups.
Well foundation- Elements of a well foundation – construction details of well foundations - Problems encountered in well sinking – Methods to rectify tilts and shifts
Site investigation and soil exploration- objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings [I.S. guidelines only]- Methods of subsurface exploration -Standard Penetration Test – procedure and correlations - Corrections for SPT value. Sampling and samplers- types -Sampler parameters - Boring log - Soil profile- Location of Water table - Geophysical methods.

v) a) TEXT BOOKS

1) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons,
3) Ranjan, G., and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 3rd edition, 2016.
4) Venkataramaiah, Geotechnical Engineering, Universities Press (India) Limited, Hyderabad, 6th edition, 2018.
5) Terzaghi, K., Theoretical Soil Mechanics, John Wiley & Sons, 1943.

b) REFERENCES

6) Bowles, J. E., *Physical and Geotechnical Properties of Soils*, McGraw-Hill Book Company, 2nd edition,1989.
7) Das, B. M., *Principles of Geotechnical Engineering*, Cengage Learning Inc, 7th Edition, 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Earth pressure: Earth pressure - At rest, active and passive earth pressures - Practical examples Rankine’s theory – Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure - Numerical problems - Earth pressure with layered backfill - Numerical problems - Coulomb’s theory [no derivation required] – Comparison of Rankine’s and Coulomb’s theory Foundation – General Considerations : Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation - Different types of shallow foundations - advantages and limitations of various types of shallow foundations	12

II	Bearing capacity of shallow foundations: Gross and Net bearing pressure - Ultimate and Safe bearing capacity - Failure mechanism - Allowable soil pressure - Terzaghi's bearing capacity theory for strip footing [no derivation required] – Assumptions – Bearing capacity factors - Numerical problems - Terzaghi's formulae for circular and square footings - Numerical problems - Factors affecting bearing capacity - Effect of water table on bearing capacity - Numerical problems - General, local and punching shear failure - Skempton's formula – Numerical problems	**12**
III	Settlement analysis: Introduction- causes of settlement – estimation of immediate settlement – Numerical problems - Allowable Settlement-Maximum and differential settlements as per Indian standard - Field test - Plate load test – Procedure, uses and limitations Footings: Principles of design of footings – strip/continuous and individual footings - Numerical Problems - Combined footings-Rectangular and Trapezoidal combined footings - Numerical problems - Footings subjected to eccentric loading Raft foundations: Types – Principles of design of raft foundation-Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula) - Floating foundations - conventional design procedure for rigid mat.	**12**
IV	Pile foundations: uses of piles - classification of piles - determination of type and length of piles - Bearing capacity of single pile in clay and sand [I.S. Static formulae] - Numerical problems - Dynamic formulae (Modified Hiley formulae only) – Numerical Problems - I.S. Pile load test [conventional] - Negative skin friction - Group action - Group efficiency - Capacity of Pile groups - Numerical problems Well foundation : Elements of a well foundation – construction details of well foundations - Problems encountered in well sinking – Methods to rectify tilts and shifts	**12**
V	Site investigation and soil exploration: objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings [I.S. guidelines only]- Methods of subsurface exploration - test pits - Auger borings – Wash Boring - Rotary drilling - Standard Penetration Test – procedure and correlations - Corrections for SPT value – Numerical Problems - Sampling - disturbed samples, undisturbed samples and chunk samples - types of samplers - Sampler parameters - Boring log – Soil profile- Location of Water table - Geophysical methods : Seismic Refraction method and Electrical Resistivity method (in brief).	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30D	HYDROLOGY AND WATER RESOURCES ENGINEERING	PCC	4	0	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The general objective of this course is to expose the students to the fundamental concepts of surface and groundwater components of hydrology and basics of water resources engineering. The course aims to impart the knowledge on the availability of water on hydrosphere, its distribution and quantification, scientific methods for computing irrigation water requirements, reservoir engineering and river engineering.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Describe the different components of hydrologic cycle by processing hydro-meteorological data	Understand
CO2	Discuss the crop water requirements for the design of irrigation canals by recollecting the principles of irrigation engineering	Apply
CO3	Calculate the design discharge of conveyance channels and stream flow parameters.	Apply
C04	Discuss the features of various river training works.	Apply
CO5	Apply the principles of reservoir engineering to estimate the capacity of reservoirs and their useful life	Apply
CO6	Demonstrate the principles of groundwater engineering and apply them for computing the yield of aquifers and wells	Apply

iv) SYLLABUS

Hydrologic cycle-precipitation-mechanism, types, forms and measurement using rain gauges, Optimum number of rain gauges, representation of rainfall data-mass curve and hyetograph, computation of mean precipitation over a catchment, Design rainfall - probable maximum rainfall; IDF curves (conceptual idea only). Infiltration-measurement by double ring infiltrometer, Horton's model, infiltration indices. Evaporation –measurement and control

Runoff-components of runoff- Hydrograph Analysis-Hydrograph from isolated storm-Base flow separation. Unit hydrograph – uses, assumptions and limitations of unit hydrograph theory. Computation of storm/flood hydrograph of different duration by method of superposition and by development of S– Hydrograph; Floods-methods of design flood estimation –Empirical methods; SPF and PMF, Return period (conceptual ideas only)

Irrigation– Necessity, Benefits and ill effects. Types: flow and lift irrigation - perennial and inundation irrigation. Soil-water –plant relationships. Irrigation efficiencies, Computation of crop water requirement- depth and frequency of Irrigation. Duty and delta, duty-factors affecting and method of improving duty, Computation of crop water requirement by using the concept of duty and delta

Streamflow measurement-area velocity method of stream gauging, selection of site for stream gauging station, Stage-discharge curve, flow duration curve-uses and characteristics. River training works-types, Meandering and meander parameters; Reservoirs- types, zones, yield of reservoir, determination of storage capacity and yield by mass curve method, Reservoir sedimentation and control- trap efficiency- computation of life of reservoir

Vertical distribution of ground water- classification of saturated formation (review) Aquifer properties, Darcy's law, well hydraulics-Steady radial flow into a fully penetrating well in Confined and Unconfined aquifers, Types of wells, Types of tube wells; well losses; Yield of open wells-pumping test and recuperation test

v) (a) TEXT BOOKS

1) Modi P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors New Delhi, 11th Edition, 2020.
2) Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd,17th Edition, 2021.
3) VenTe Chow. Hand book of Applied Hydrology, Tata McGraw Hill, 2017.
4) Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers New Delhi 2010.

(b) OTHER REFERENCES

6) G.L.Asawa. Irrigation and Water Resources Engineering New Age International New Delhi,2008.
7) Garg SK, Irrigation Engineering and Hydraulic Structures Khanna Publishers New Delhi, 2006.
8) Subramanya K. Engineering Hydrology, Tata McGraw Hill, 2017.
9) Raghunath H.M. Hydrology: Principles, Analysis and Design. New Age International New Delhi ,2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Hydrology-Hydrologic cycle, Precipitation- mechanism, types, forms, Measurements of rainfall- Use of rain gauges, Representation of rainfall data-Rainfall Mass curve, hyetograph, Optimum number of rain gauges, Estimation of missing precipitation, Computation of mean precipitation, Problems, Design rainfall probable max rainfall, IDF curves (conceptual idea only). Water losses-Infiltration-measurement by double ring infiltrometer, Horton’s equation; concept of infiltration indices, evaporation-measurement by IMD land pan, control of evaporation	12
II	Runoff- Components, factors affecting runoff, Computation of runoff by different methods. Runoff computation by rational formula and from infiltration indices, Hydrograph Analysis-Hydrograph from isolated storm-Base flow separation, Concept of unit hydrograph-assumptions, uses, applications. Computation of storm/flood hydrograph ordinates of different duration by method of superposition, Computation of storm/flood hydrograph ordinates of different duration by development of S– Hydrograph, Problems, Floods-methods of design flood estimation –Empirical methods, SPF and PMF, Return period (conceptual ideas only)	12
III	Irrigation-Benefits and ill effects, lift and flow irrigation, Types of irrigation, Irrigation efficiencies, Soil water plant relationships Computation of crop water requirement: depth and frequency of Irrigation, Duty and delta-Factors affecting and method of improving duty, Estimation of crop water requirement by using the concepts of duty and delta, Problems	12
IV	Streamflow measurement- measurement of stage and velocity, Stage-discharge curve- Selection of site for stream gauging station, Computation of discharge (Area-velocity method)- problem, Flow duration curves-uses and characteristics, River behaviour-meandering-meander parameters, Objectives of river training ,Types of river training works, Reservoirs- types, zones, yield of reservoir Storage capacity and yield-by mass curve method, Reservoir sedimentation-control of sedimentation, trap Efficiency ,Useful life of reservoir-computation. Problems	12
V	Vertical distribution of ground water - classification of saturated formation (Review), Aquifer properties- Darcy’s law, Steady radial flow to a well-unconfined aquifer, Steady radial flow to a well-unconfined aquifer, Problems, Types of wells-open wells and tube well, Types of	12

	tube wells- description, Estimation of yield of an open well- pumping test and recuperation test	
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30E	CONSTRUCTION TECHNOLOGY AND MANAGEMENT	PCC	3	0	0	3	2020

i) COURSE OVERVIEW

The course provides a detailed insight into the materials used in construction, various building elements and construction technology. Management is essential for successful completion of construction projects and the course introduces the students to the basic concepts of construction project management and planning. After the course, students will be familiar with the fundamental concepts of building construction and management.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the properties of materials used in construction.	Understand
CO 2	Explain the properties of concrete and its determination.	Understand
CO 3	Describe the various elements of building construction.	Understand
CO 4	Explain the technologies for construction.	Understand
CO 5	Describe the procedure for planning and executing public works.	Understand
CO6	Apply scheduling techniques in project planning and control.	Apply

iii) SYLLABUS

Construction Materials Timber products –properties and uses of veneer, plywood, fibre board, particle board, multi wood Cement: Manufacturing, chemical composition, Tests on cement – specific gravity, standard consistency, initial and final setting time, fineness, soundness, compressive strength, IS specifications Aggregates – types, Gradation, importance of gradation, bulking of fine aggregate Quality of water for construction (Brief discussion only, Permissible limits of chemical constituents not required) Admixtures, uses – mineral admixtures – fly ash and ground granulated blast furnace slag and chemical admixtures – plasticizers, super plasticizers, accelerators, retarders (brief discussion only).

Concrete and Building Construction Process of manufacturing concrete – batching, mixing, transportation, placing, compacting, finishing, curing Properties of fresh concrete: Workability, factors affecting workability, test on workability (slump test), segregation and bleeding (brief discussion) Properties of hardened concrete: Strength, factors affecting strength, tests for strength of concrete in compression, tension and flexure Lintels and arches: Types and construction details Damp proof course (brief discussion only) Finishing works:

Plastering, pointing, painting – objectives and types Structural systems – load bearing and framed construction, RCC and steel framed structures.

Cost-effective construction – rapid wall construction, soil-cement block masonry, voided slab technology, filler slab technology (brief discussion only) Scaffolding – uses and classification (brief discussion only) Formwork – requirements of good formwork, classification, slipform (brief discussion only) Prefabricated construction – advantages and disadvantages, prefabricated building components. Basic concept of prestressing – fundamental understanding of pre-tensioned and post-tensioned construction Construction 3D printing (brief discussion only) Building failures – general reasons Causes of failures in RCC, steel and masonry structures.

Construction projects, categories, life cycle of a project –pre-project phase, project phase, post project phase, Detailed Project Report, Tendering: types of tenders, stages in tendering Contracts: types of contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, concession contracts – BOT.

Construction Planning Work break down structure Types of Schedules – Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule Bar chart, Mile Stone Charts Networks, Network representation – Activity on Node (AoN) Diagram Network analysis – Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT) – concepts and problems.

iv) (a) TEXT BOOKS

1) Shetty M.S. and A. K. Jain, Concrete Technology: Theory and Practice, S. Chand & Company Pvt. Ltd, 2019.
2) Sharma S.C. and S.V. Deodhar, Construction Engineering & Management, Khanna Book Publishing Co. (P) Ltd,2019.
3) Punmia B. C., Ashok Kumar Jain and Arun Kumar Jain, Building Construction, Laxmi Publications (P) Ltd, 2016.
4) Kumar Neeraj Jha, Construction Project Management: Theory and Practice, Pearson India Education Services Pvt.Ltd, 2015.
5) Varghese P. C., Building Construction, Prentice Hall India, 2007.

(b) OTHER REFERENCES

6) Sahu G. C.and Joygopal Jena, Building Materials and Construction, McGraw Hill Education (India) Private Limited, 2015.
7) Gambhir M. L., Concrete Technology, Tata McGraw-Hill Publishing Company Limited, 2004.
8) Sharma S.K., Civil Engineering Construction Materials, Khanna Book Publishing Co. (P) Ltd,2019.
9) Neville A.M. and Brooks J. J., Concrete Technology, Pearson Education Ltd,2010.
10) Mehta P. K. and Paulo J. M. Monteiro, Concrete-Microstructure, Properties and Materials, McGraw Hill Education,2014.
11) Tony Bryan, Construction Technology – Analysis and Choice, Wiley-Blackwell, 2010.
12) Charles Patrick, Construction Project Planning and Scheduling, Dorling Kindersley India Pvt. Ltd, 2012.

13) Daniel W. Halpin and Bolivar A. Senior, Construction Management, John Wiley and Sons Inc, 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	Timber products –properties and uses of veneer, plywood, fibre board, particle board, multi wood. Cement – Manufacturing,chemical composition. Tests on cement – specific gravity, standard consistency, initial and final setting time, fineness, soundness, compressive strength, IS specifications. Aggregates – types, Gradation, importance of gradation, bulking of fine aggregate. Quality of water for construction (Brief discussion only, Permissible limits of chemical constituents not required) Admixtures, uses – mineral admixtures – fly ash and ground granulated blast furnace slag and chemical admixtures – plasticizers, superplasticizers, accelerators, retarders (brief discussion only)	8
II	Concrete manufacturing – batching, mixing, transportation, placing, compacting, finishing, curing. Properties of fresh concrete: Workability, factors affecting workability, test on workability (slump test), segregation and bleeding (brief discussion). Properties of hardened concrete: Strength, factors affecting strength, tests for strength of concrete in compression, tension and flexure. Lintels and arches: Types, Damp proof course (brief discussion only), Finishing works: Plastering, pointing (objectives and types), Painting (objectives and types), Structural systems – load bearing and framed construction, RCC and steel framed structures.	10
III	Cost-effective construction – rapid wall construction, soil-cement block masonry, voided slab technology, filler slab technology (brief discussion only), Scaffolding – uses and classification (brief discussion only), Formwork – requirements of good formwork, classification, slipform (brief discussion only), Prefabricated construction – advantages and disadvantages, prefabricated building components. Basic concept of prestressing – fundamental understanding of pre-tensioned and post-tensioned, construction Construction 3D printing (brief discussion only), Building failures – general reasons Causes of failures in RCC, steel and masonry structures.	8
IV	Introduction to construction project management, construction projects, categories. Life cycle of construction project – pre-project phase, project phase, post-project phase,Detailed Project Report – contents. Tendering, types of tenders, stages in tendering. Contracts – types of contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, concession contracts – BOT	9

V	Introduction to construction planning and scheduling, Work break down structure, Types of Schedules: Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule, Bar chart,Mile Stone Charts. Introduction of networks, Network representation – Activity on Node (AoN) Diagram, Critical Path Method (CPM) – concepts and problems on determination of critical path, floats. Programme Evaluation and Review Technique (PERT) – concepts and problems	**10**
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U30A	DISASTER MANAGEMENT	HSC	2	0	0	Nil	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of hazards and disaster management. The course details the various phases of disaster risk management and the measures to reduce disaster risks.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts and terminology related to disaster management cycle	Understand
CO 2	Explain hazard and vulnerability types and disaster risk assessment	Understand
CO 3	Describe the process of risk assessment and appropriate methodologies to assess risk	Understand
CO 4	Explain the core elements and phases of disaster risk management and measures to reduce disaster risks across sector and community	Apply
CO 5	Discuss the factors that determine the nature of disaster response and the various disaster response actions	Understand
CO 6	Explain the legislations and best practices for disaster management and risk reduction at national and international level	Understand

iv) SYLLABUS

Introduction- Systems of Earth, Key concepts and terminology in disaster risk reduction and management.

Hazard types, Vulnerability types and their assessment, Disaster risk assessment.

Disaster risk management- Phases of disaster risk management, Measures for disaster risk reduction- prevention, mitigation, preparedness, Disaster response, Relief

Participatory stakeholder engagement, Disaster communication, Capacity building.

Common disaster types in India, Legislations in India on Disaster Management, National Disaster Management Policy, Institutional arrangements for disaster management in India, The Sendai Framework for Disaster risk reduction.

v) (a) TEXT BOOKS

1) Coppola, D.P., *Introduction to International Disaster Management*, Elsevier Science (B/H), London, 2020
2) Srivastava, H.N., Gupta, G.D., *Management of Natural Disasters in developing countries*, Daya Publishers, Delhi, 2007
3) Subramanian, R., *Disaster Management*, Vikas Publishing House, 2018
4) Sulphey, M.M., Disaster *Management*, PHI Learning, 2016

(b) OTHER REFERENCES

1) NDMA*, National Policy on Disaster Management*, Ministry of Home Affairs, Government of India,2009.
2) National Disaster Management Division, *Disaster Management in India - A Status Report*, Ministry of Home Affairs, Government of India, New Delhi,2004.
3) *National Disaster Management Plan*, NDMA, Ministry of Home Affairs, Government of India,2019.
4) *Disaster Management Training Manual*, UNDP, 2016
5) United Nations Office for Disaster Risk Reduction, *Sendai Framework for Disaster Risk Reduction 2015-2030*, 2015

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction about various systems of earth, Lithosphere- composition, rocks, soils; Atmosphere- layers, ozone layer, greenhouse effect. Weather, cyclones, atmospheric circulations, Indian monsoon; Hydrosphere- oceans, inland water bodies; Biosphere Definition and meaning of key terms in Disaster risk reduction and Management – disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment	6
II	Various hazard types, hazard mapping; Different types of vulnerability types and their assessment- Physical, social, economic and environmental vulnerability. Core elements of disaster risk assessment Components of a comprehensive disaster preparedness strategy approaches, procedures	6

	Different disaster response actions	
III	Introduction to disaster risk management, core elements of disaster risk management Phases of disaster risk management, Measures for disaster risk reduction Measures for disaster prevention, mitigation, and preparedness Disaster response- objectives, requirements. Disaster response planning; types of responses Disaster relief, International relief organisations	**7**
IV	Participatory stakeholder engagement, Importance of disaster communication, Disaster communication- methods, barriers, Crisis counselling Introduction to capacity building, Concept- Structural measures, Non-structural measures Introduction to Capacity assessment, Capacity assessment- Strengthening, Capacity for reducing risk	**5**
V	Introduction- common disaster types in India Common disaster legislations in India on disaster management National disaster management policy, Institutional arrangements for disaster management in India. The Sendai Framework for Disaster risk reduction and targets- priorities for action, guiding principles	**6**
	Total hours	**30**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U38A	MATERIAL TESTING LAB II	PCC	0	0	3	3	2020

i) COURSE OVERVIEW

The course aims to enrich the students to gain hands-on experience in conducting laboratory tests on various construction materials and thereby evaluate material quality and performance.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the basic properties of various construction materials	Understand
CO 2	Describe the physical and mechanical properties of various construction materials.	Understand
CO 3	Interpret the quality of various construction materials as per IS Codal provisions	Understand

iii) LIST OF EXPERIMENTS

1. Testing of Cement: Fineness, normal consistency, initial & final setting time.
2. Testing of Cement: Specific gravity and compressive strength, Study on soundness of cement.
3. Testing of Coarse and Fine Aggregate: Sieve analysis.
4. Testing of Coarse and Fine Aggregate: Water absorption, bulk density, void ratio, porosity and specific gravity.
5. Test on bulking of sand.
6. Test on coarse aggregate crushing value
7. Tests on fresh concrete: Measurement of workability of concrete by slump cone.
8. Test and compacting factor test.
9. Study on workability of concrete by Vee-Bee test and flow test.
10. Concrete mix design by IS code method and casting of cubes, cylinders with designed concrete mixes.
11. Tests on hardened properties of concrete: Compressive, split and flexural strength.
12. Tests on hardened properties of concrete: Modulus of elasticity of concrete
13. Tests on brick, floor and roof tiles as per IS codal provision.
14. Study on Non-destructive tests on hardened concrete (Rebound hammer, ultrasonic pulse velocity and Rebar locator).
15. Study on concrete core cutter, concrete penetrometer and crack detection Microscope.

iv) COURSE PLAN

Experiment No.	List of Experiments/Exercises	No. of hours
1	Testing of Cement: Fineness, normal consistency, initial & final setting time.	3
2	Testing of Cement: Specific gravity and compressive strength, Study on soundness of cement.	3
3	Testing of Coarse and Fine Aggregate: Sieve analysis.	3
4	Testing of Coarse and Fine Aggregate: Water absorption, bulk density, void ratio, porosity and specific gravity.	3
5	Test on bulking of sand.	3
6	Test on coarse aggregate crushing value	3
7	Concrete mix design by IS code method and casting of cubes, cylinders with designed concrete mixes.	3
8	Tests on fresh concrete: Measurement of workability of concrete by slump cone.	
9	Test and compacting factor test.	
10	Study on workability of concrete by Vee-Bee test and flow test.	3
11	Tests on hardened properties of concrete: Compressive, split and flexural strength.	
12	Tests on hardened properties of concrete: Modulus of elasticity of concrete	3
13	Tests on brick, floor and roof tiles as per IS codal provision.	
14	Study on Non-destructive tests on hardened concrete (Rebound hammer, ultrasonic pulse velocity and Rebar locator).	3
15	Study on concrete core cutter, concrete penetrometer and crack detection	
	Total hours	**30**

v) REFERENCES

1) M.S. Shetty, Concrete Technology, Theory and Practice, S. Chand &Company, 2014.

2) A.M. Neville and J.J Brooks, Concrete Technology, Second edition, Pearson.

3) IS codes on cement: IS 1489(Part 1& 2):1991 Specification for Portland pozzolana cement, IS 269:1989 – Specification for ordinary Portland cement, 33 grade, IS 8112: 2013- Specification for ordinary Portland cement, 43 grade, IS 12269: 2013- Specification for ordinary Portland cement, 53 grade,

4) IS codes on aggregate: IS 2386(Part 1):1963 Methods of test for aggregates for

   concrete: Part 1 Particle size and shape, IS 2386(Part 3):1963 Methods of test for aggregates for concrete: Part 3 Specific gravity, density, voids, absorption and bulking, IS 383:1970Specification for Coarse and Fine aggregate from natural sources of concrete.

5) IS codes on fresh and hardened concrete: IS 1199:1959 Methods of sampling and Analysis of concrete, IS 10262:2019 Concrete mix proportioning- Guidelines, IS 516:1959 Methods of tests for strength of concrete.

6) IS codes on brick and tiles: IS 3495 (Part 1 to 4):1992 Methods of tests of burned clay bricks, IS 1077:1992 Common burned clay building bricks (specification), IS 654:1992 Clay roofing tiles Mangalore pattern (specification).

7) IS 13311 (Part 1 & 2):1992Non - destructive testing of concrete-methods of test.

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U38B	GEOTECHNICAL ENGINEERING LAB	PCC	0	0	3	2	2020

i) COURSE OVERVIEW:

This course deals with hands on training in determination of Engineering and Index properties of soil, applied to field problems

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the principles and procedures of laboratory tests used for determination of index and engineering properties of soils.	Apply
CO 2	Classify soils and interpret engineering behaviour of soils.	Apply
CO 3	Evaluate the permeability and shear strength of soils.	Apply
CO 4	Evaluate compaction characteristics required for field application.	Apply
CO5	Evaluate settlement characteristics of soils.	Apply

iii) SYLLABUS

LIST OF EXPERIMENTS

1. Determination of Soil Moisture Content.
2. Determination of Grain size or Particle size distribution of Soil.
3. Determination of Specific Gravity.
4. Determination of Consistency or Atterberg’s Limits.
5. Determination of In-situ density test or Field density test.
6. Determination of Unconfined Compression test.
7. Determination of Optimum Moisture Content (OMC).
8. Determination of Permeability test.
9. Determination of Shear parameters.
10. Determination of Coefficient of Consolidation.

iv) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
Determine the Index properties of soils		
I	Determination of Soil Moisture Content.	**1**
II	Determination of Grain size or Particle size distribution of Soil.	**3**
III	Determination of Specific Gravity.	**2**
IV	Determination of Consistency or Atterberg's Limits.	**3**
V	Determination of In-situ density test or Field density test.	**3**
VI	Determination of Unconfined Compression test.	**3**
Determine the Engineering properties of soils		
VII	Determination of Optimum Moisture Content (OMC).	**3**
VIII	Determination of Permeability test.	**3**
IX	Determination of Shear parameters.	**3**
X	Determination of Coefficient of Consolidation.	**3**
	Total hours	**30**

v) REFERENCES

1) Lambe, T.W., *Soil Testing for Engineers*, Wiley Eastern Limited, New Delhi.
2) Head, K.H., Manual *of Soil Laboratory Testing Vol. I, II, III*, Princeton Press.
3) Ranjan, G., and Rao, A.S.R., *Basic and Applied Soil Mechanics,* New Age International (P) Limited, New Delhi, 3rd edition, 2016.
4) Venkataramaiah, *Geotechnical Engineering*, Universities Press (India) Limited, Hyderabad, 6th edition, 2018.
5) IS: 2720(Various parts), *Method of Test for Soils*, *Preparation of dry soil samples for various Tests*, Bureau of Indian Standards, New Delhi.
6) IS: 2720(Part 3-1980), *Specific Gravity Test of Soil by Pycnometer Method*, Bureau of Indian Standards, New Delhi
7) IS: 2720(Part 28-1974), *Determination of in-situ dry density of soil by the Sand Replacement Method*, Bureau of Indian Standards, New Delhi
8) IS: 2720(Part 39-1977), *Direct Shear Test for soils*, Bureau of Indian Standards, New Delhi
9) IS: 2720(Part 8-1983), *Proctor Density Test*, Bureau of Indian Standards, New Delhi

10) IS: 2720(Part 17-1986),Permeability Test, Bureau of Indian Standards, New Delhi

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

SEMESTER – VI

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit
CE1U30F	STRUCTURAL ANALYSIS II	PCC	3	1	0	4

i) PRE-REQUISITE: CE1U30A STRUCTURAL ANALYSIS I

ii) COURSE OVERVIEW:

The course enables the students to analyse various types of multistoreyed structures using appropriate methods and tools. It utilises the procedures of force methods and displacement methods for analysing framed structures. Principles of dynamics to analyse structures while undergoing dynamic deformations is made familiar with. The course trains the students to develop mathematical models and helps to sharpen their analytical skills.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Analyse beams and portal frames by equilibrium and mechanism methods	Analyse
CO 2	Analyse different types of structures using approximate method.	Analyse
CO 3	Analyse trusses, continuous beams and rigid frames using flexibility method and stiffness method.	Analyse
CO 4	Analyse two span continuous beam and single bay single storey portal frame by direct stiffness method.	Analyse
CO 5	Interpret basics of structural dynamics and analyse the response of SDOF systems.	Understand

iv) SYLLABUS

Plastic analysis of beams and portal frames by equilibrium and mechanism methods. Approximate methods of analysis of multi-storeyed frames, Analysis for vertical loads-substitute frames, portal method and cantilever method for lateral load analysis. Matrix analysis of structures, Development of flexibility and stiffness matrices by physical approach, analysis of simple structures, plane truss and plane frame. Direct stiffness method, stiffness matrix of elements in global co- ordinates from element co-ordinates, solution of two span continuous beam-single bay single storey portal frame. Structural dynamics, D'Alembert's principle, single degree of freedom systems

v) (a) TEXT BOOKS

3) Weaver W. Jr. and Gere J. M., *Matrix analysis of framed structures*, CBS Publishers, New Delhi, 2019.

4) Rajasekharan S. and Sankarasubramanian G., *Computational Structural Mechanics*, Prentice Hall of India, New Delhi, 2015.

5) Hibbeler R. C., *Structural Analysis*, Pearson Education, New Delhi, 2012.
6) Ghali A., Neville A. M. And Brown T. G., *Structural Analysis – A unified classical and matrix approach*, Spon Press, London and Newyork, 2009.
7) Pandit G. S. and Gupta S. P., *Structural analysis – A Matrix Approach*, Tata McGraw Hill, New Delhi, 2008.

(b) OTHER REFERENCES

8) Chandrapatla T. R. and Belegundu A. D., *Introduction to Finite Elements in Engineering*, Prentice Hall of India, New Delhi, 2012.
9) Cook R.D., *Concepts and applications of Finite Element Analysis*,John Wiley & Sons,Dallas, 2005.
10) Krishnamoorthy C. S., *Finite Element Analysis – Theory and Programming*, Tata McGraw Hill, New Delhi, 2004.
11) Rajasekharan S., *Finite Element Analysis in Engineering Design*, WheelerPublishers, 1993.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Plastic Theory: Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods. (single storey and single bay frames only) Approximate methods of analysis of multistoried frames: Analysis for vertical loads-substitute frames-loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns.	**12**
II	Approximate methods (continued): Wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis. Matrix analysis of structures: Definition of flexibility and stiffness influence coefficients - Concepts of physical approach Flexibility method: flexibility matrices for truss and frame elements-load transformation matrix-development of total flexibility matrix of the structure-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects.	**12**
III	Stiffness method: Development of stiffness matrices by physical approach-stiffness matrices for truss and frame elements-displacement transformation matrix-analysis of simple structures-	**12**

	plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects.	
IV	Direct stiffness method: Introduction to direct stiffness method-Rotation of axes in two dimensions, stiffness matrix of elements in global co- ordinates from element co-ordinates- assembly of load vector and stiffness matrix, solution of two span continuous beam-single bay single storey portal frame.	**12**
V	Structural dynamics: Introduction - degrees of freedom - equation of motion, D'Alembert's principle-damping- free response of damped and undamped systems- logarithmic decrement-- single degree of freedom systems subjected to harmonic load - transient and steady state responses, simple portal frame problems.	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit
CE1U30G	ENVIRONMENTAL ENGINEERING	PCC	4	0	0	4

i) PRE-REQUISITE: CE1U20B FLUID MECHANICS AND HYDRAULICS, CE1U30D HYDROLOGY &WATER RESOURCES ENGINEERING

ii) COURSE OVERVIEW

Goal of this course is to expose the students to water quality standards and the various treatment processes for the purification of drinking water and domestic wastewater. The course also details the various aspects of water supply and sanitation.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Estimate water demand and quantity of wastewater generated	Apply
CO 2	Explain the methods for collection and conveyance of water and wastewater.	Understand
CO 3	Describe the various physical, chemical and biological processes for the treatment of drinking water and domestic wastewater	Understand
CO 4	Design the various units of a water and wastewater treatment plant	Apply
CO 5	Solve water distribution networks using Hardy cross and Equivalent pipe method	Apply

iv) SYLLABUS

Introduction to environmental engineering and role of environmental engineers: Water quantity estimation- Estimation for waste water quantity- Collection and conveyance- Systems of sewerage

Layout plan of a conventional water treatment plant: Theory and principles of sedimentation- Mechanisms of coagulation and flocculation, popular coagulants and feeding devices

Filtration of water: theory of filtration- design of a rapid sand filter - Disinfection of water - Lay out of water distribution network- network analysis -Hardy cross and equivalent pipe methods

Layout plan of a conventional waste water treatment plant: concept of primary, secondary and tertiary treatment- Unit operations in waste water- Activated sludge process- Trickling filter

Anaerobic treatment of high strength waste water: Up flow Anaerobic Sludge Blanket (UASB) Natural waste water treatment systems- Low cost sanitation systems- Sludge treatment

v) a) TEXTBOOKS

1) Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., *Environmental Engineering*, McGraw Hill Education, 2017
2) Davis, M.L., Cornwell, D.A., *Introduction to Environmental Engineering*, McGraw Hill Education, 2017
3) Garg, S.K., *Water Supply Engineering*, Khanna Publishers, 2010
4) Birdie, G.S.,*Water Supply and Engineering*, DhanapatRai Publishing Company, 2014
5) Arceivala, S.J., Asolekar, S. R., *Wastewater Treatment for Pollution Control and Reuse,*McGrawhill Education, 2017
6) Garg, S.K., *Sewage disposal and air pollution engineering*, Khanna Publishers, 2021

b) OTHER REFERENCES

1) Metcalf and Eddy, *Waste Water Engineering*, Tata McGraw Hill publishing Co Ltd, 2012.
2) Qasim, S. R., Motley, E.M., Zhu, G., *Water Works Engineering-Planning, Design & Operation*, PHI Learning, 2012.
3) Qasim, S.R.,*Wastewater Treatment Plants-Planning, Design & Operation*, CRC Press, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to environmental engineering and role of environmental engineers-enhancingnatural purification processes in an engineered environment-public health perspective fortreating water and waste water Water quantity estimation:Population forecast- water demand estimation-types of demand- demand fluctuation Estimation for waste water quantity:Dry weather flow and storm water flow-population equivalent-design period Collection and conveyance:water intake structures- -gravity flow and pressure flow systems Systems of sewerage: separate and combined-types of pumps for water and waste waterconveyance	10

II	Layout plan of a conventional water treatment plant- site selection-concept of unit operationsand unit processes-Screening-types of screens -aeration -aerator types Theory and principles of sedimentation-Stoke's law-Types of settling -Design of plain sedimentation tanks Mechanisms of coagulation and flocculation, popular coagulants and feeding devices	**12**
III	Filtration of water-theory of filtration-types of filters - design of a rapid sand filter Disinfection of water - various methods - advantages and limitations Lay out of water distribution network-types-methods of distribution-network analysis –Hardycross and equivalent pipe methods	**12**
IV	Layout plan of a conventional waste water treatment plant- site selection- concept of primary,secondary and tertiary treatment Unit operations in waste water- primary treatment -equalization of flow Secondary treatment methods-basic concepts of biological unit processes-aerobic andanaerobic- attached and suspended growth processes (Concepts only) Activated sludge process- basic concepts-design of a conventional Activated Sludge Plant Trickling filter (Concept only)- types- construction & operation	**13**
V	Anaerobic treatment of high strength waste water- Up flow Anaerobic Sludge Blanket (UASB) reactor (Concept only) Natural waste water treatment systems-Oxidation Ponds and Lagoons-Wetlands and Rootzone systems (Concepts only) Low cost sanitation systems- Design of a septic tank and soak-pit Sludge treatment (concepts only) -thickening- digestion-dewatering- drying- composting	**13**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30H	DESIGN OF HYDRAULIC STRUCTURES	PCC	4	0	0	4	2020

i) PRE-REQUISITE: CE1U20B FLUID MECHANICS AND HYDRAULICS, CE1U30D HYDROLOGY AND WATER RESOURCES ENGINEERING.

ii) COURSE OVERVIEW:

Goal of this course is to expose students to the fundamental concepts in the design of various hydraulic structures. This course equip the students to perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls and regulators and prepare drawings of the same. An ability to interpret the causes of failure and stability criteria of dams and canal structures is also developed.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Discuss the concepts of diversion headworks, canal structures, spillways and stilling basins.	Understanding
CO 2	Examine minor irrigation structures such as cross drainage works, canal falls, cross regulators and vertical drop weir.	Applying
CO 3	Prepare the scaled drawings of minor irrigation structures such as cross drainage works, canal falls, cross regulators and vertical drop weir.	Applying
CO 4	Explain the design aspects and failure criteria of various dams.	Understanding
CO 5	Solve the stability analysis of gravity dams.	Applying

iv) SYLLABUS

Diversion headwork - Weirs - Barrage - Bligh's theory - Khosla's theory, Canals-Lacey's theory-Kennedy's theory, Canal structures - Cross drainage structures, Canal falls, Hydraulic design and drawing - Aqueduct - Syphon Aqueduct-Trapezoidal notch fall - Sarda fall - Cross regulator, Introduction to dams - types - forces acting- modes of failure - Stability analysis, Spillways, Stilling basins.

v) (a) TEXT BOOKS

1) Modi. P. N., *Irrigation, Water Resources and Water Power Engineering*, S.B.H Publishers and Distributors New Delhi, 11th edition, 2019.
2) Garg S.K, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers New Delhi, 35th edition, 2019.
3) Arora, K. R., *Irrigation, Water Power and Water Resources Engineering*, Standard Publishers Distributors, New Delhi, 4th edition, 2014.
4) Punmia B.C., Ashok K Jain, Arun K Jain, Pande B. B. L., *Irrigation and Water Power Engineering*, Laxmi Publications (P) Ltd., 3rd edition, 2010.

(b) OTHER REFERENCES

5) Sathyanarayana M. C., *Water Resources Engineering-Principles and Practice*, New Age International Publishers, 2nd edition, 2020.
6) Arya Sahasrabudhe S. R., *Irrigation Engineering and Hydraulic Structures*, S.K. Kataria& Sons, 3rd edition, 2011.
7) Varshney R.S., *Theory and Design of Irrigation Structures - Vol II*, Nem Chand & Bros., Roorkee, 7th edition, 2007.
8) Asawa. G.L., *Irrigation and Water Resources Engineering*, New Age International Publishers, 2005.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Diversion headwork-components and functions; Weirs – types and causes of failure- Impervious floor of hydraulic structures –Bligh's theory, Design of vertical drop weir; Design of impervious floor of hydraulic structures by Khosla's theory	11
II	Canals-types, Cross section of unlined canals and alignment; Design of canals through alluvial soils- Kennedy's theory and Lacey's silt theory. Canal structures- cross drainage structures types; Canal falls-Necessity, types	11
III	Hydraulic design and drawing of canal structures (i) Aqueduct; (ii) Siphon Aqueduct; (iii) Canal drop (Trapezoidal Notch Fall); (iv) Sarda type fall (trapezoidal crest- impervious floor design using Khosla's theory); (v) Cross regulator (impervious floor design using Khosla's theory)	20
IV	Dams-types; Gravity Dams-computation of forces-modes of failure and stability criteria, stability analysis. Elementary and practical profile, limiting height of gravity dams, Galleries, joints, keys, water stops, instrumentation, grouting (brief description only)	10

V	Earth dams-types, causes of failure and design criteria, Arch dams-thin cylinder theory; Spillways-types-Ogee spillway profile; Energy dissipation- stilling basins-Indian standard Type I and Type II (description only)	**8**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers) *(For the first internal test, minimum two design should be included)*	:	25 marks
Assignment/Quiz/Course Project *Assignment should be scaled drawings (in A2 size sheet)*	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U30A	INDUSTRIAL ECONOMICS & FOREIGN TRADE	HSC	3	0	0	3	2020

i) PRE REQUISITE: NIL

ii) COURSE OVERVIEW:

The course enables students to make better economic decisions in wage employment and entrepreneurship using economic alternatives and investment alternatives.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Learning Level
CO 1	Explain the problem of scarcity of resources, consumer behaviour and the equilibrium condition of demand and supply.	Understand
CO 2	Demonstrate the production function and equilibrium condition of a producer	Understand
CO 3	Survey the functional requirement of a firm under various competitive conditions.	Analyse
CO 4	Infer the overall performance of the economy, the regulation of economic fluctuations and its impact on various sections in the society.	Analyse
CO 5	Compare the profitability of projects and businesses with the help of capital budgeting methods	Evaluate
CO 6	Determine the current impact of global economic policies on the business opportunities of a firm	Analyse

iv) SYLLABUS

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency

Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation- causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers

v) REFERENCE BOOKS

1) Gregory N Mankiw, '*Principles of Micro Economics*', Cengage Publications 2015
2) Gregory N Mankiw, '*Principles of Macro Economics*', Cengage Publications 2012
3) Dwivedi D.N., '*Macro Economics*', Tata McGraw Hill, New Delhi
4) Mithani D M, '*Managerial Economics*', Himalaya Publishing House, Mumbai
5) Tulsian, '*Financial Management*' S Chand & Company 2017
6) Francis Cherunilam, '*International Economics*', McGraw Hill, New Delhi

vi) COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	8
II	Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.	8
III	Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a	

	firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency	9
IV	Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation- causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares - Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio	**11**
V	Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30I	COMPREHENSIVE COURSE WORK	PCC	1	0	0	1	2020

i) COURSE OVERVIEW:

The course is designed to ensure the foundational knowledge in Civil Engineering familiar enough with the technological concepts. It provides an opportunity for the students to demonstrate their knowledge in various Civil Engineering subjects.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Prepare for a competitive examination	Understand
CO 2	Describe the questions in Civil Engineering field and answer them with confidence	Understand
CO 3	Explain the comprehensive knowledge gained in basic courses in the field of Civil Engineering	Understand

iii) SYLLABUS

Mechanics of solids-Concept of stress and strain, Concept of bending moment and shear force, Theory of simple bending.

Fluid Mechanics and Hydraulics-Fluid properties; Fluid statics, measurement of fluid pressure. Buoyancy and Floatation, Bernoulli's equation and its applications; Pipe flow- Open channel flow, velocity distribution in open channels, uniform flow computations, Most economical sections, Specific energy, Critical flow; Hydraulic jump.

Surveying & Geomatics-Introduction to Surveying, Bearing of survey lines, Principles of levelling. Traverse Surveying, Checks in closed traverse; Theory of Errors, Total Station – concept of EDM, principles and working. GPS-Components and principles. Remote Sensing.

Geotechnical Engineering, I-Definitions and properties of soil, 3 phase system, Index properties of soil, Soil classification, Effective stress, Quick sand condition, Stress distribution, Permeability of soil, Darcy's law, Consolidation, Compaction, shear strength of soil, Triaxial compression test, Unconfined compression test, Direct shear test and Vane shear test.

Construction Technology and Management-Cement: Manufacturing, Properties of fresh concrete and hardened concrete. Types of stone masonry – composite walls - cavity walls and partition walls - Construction details and features. Finishing works, Prefabricated construction – advantages and disadvantages, Prefabricated building components. Causes of failures in RCC and Steel structures. Types of tenders, Types of contracts. Types of Schedules. Network analysis –CPM, PERT – concepts and problems.

iv) a) TEXT BOOKS

1) Timoshenko, Strength of Materials Vol. I & Vol. II, CBS Publishers & Distributers, New Delhi, 3 rd edition, 2004.

2) Modi, P. N. and Seth, S. M., Hydraulics and Fluid Mechanics, S. B. H. Publishers, 22 nd edition, New Delhi, 2019.

3) Schofield, W. and Breach, M., Engineering Surveying, Butterworth-Heinemann, 5th Edition, 2007.

4) Ranjan, G., and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 3 rd edition, 2016.

5) Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers, 4 th Edition, 2017.

b) REFERENCES

6) Gere, J.M., Goodno, B. J., Mechanics of Materials, Cengage Learning, 9th edition, 2016.

7) Bansal, R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 10 th edition, 2018.

8) Venkatramaiah, C., Textbook of Surveying, Universities Press (India) Private Limited, 2nd Edition, 2011.

9) Bowles, J. E., Physical and Geotechnical Properties of Soils, McGraw-Hill Book Company, 2nd edition,1989.

10) Chen, W. F. and Liew, J. Y. R. (Eds), The Civil Engineering Handbook, CRC Press (Taylor and Francis), 2 nd Edition, 2002

v) COURSE PLAN

Module	Contents	No. of hours
I	Concept of stress and strain, Hooke's law, Stress-strain diagram of mild steel; Axially loaded bars. Temperature stress in composite bars, Poisson's ratio, Elastic constants and the relationship between them. Beams, Concept of bending moment and shear force, Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different type of loads. Theory of simple bending; Shear stress in beams. Principal stresses and principal planes in 2D problems, maximum shear stress; Mohr's circle.	4
II	Fluid properties; Fluid statics, measurement of fluid pressure. Buoyancy and Floatation: Buoyant force, Principle of floatation, stability of floating and submerged bodies, metacentre and metacentric height; continuity equation in one, two and three dimensions. Bernoulli's equation and its applications; Pipe flow-computation of major and minor losses in pipes, equivalent pipe. Open channel flow, velocity distribution in open channels, uniform	3

	flow computations, Most economical sections, Specific energy, Critical flow; Hydraulic jump.	
III	Introduction to Surveying- Principles, Linear, angular and graphical methods. Bearing of survey lines, Local attraction, Declination; Principles of levelling, Methods of levelling. Theodolite surveying, Measurement of horizontal and vertical angle; Triangulation. Traverse Surveying, Checks in closed traverse; Theory of Errors – Types, theory of least squares, Weighting of observations. Total Station – concept of EDM, principles and working. GPS-Components and principles. Remote Sensing.	**2**
IV	Definitions and properties of soil, 3 phase system, Index properties of soil, Soil classification, Effective stress, Quick sand condition, Stress distribution, Permeability of soil, Darcy's law, Factors affecting permeability, Laboratory tests, Consolidation, Normally consolidated, over consolidated and under consolidated soils, Time factor, Coefficient of consolidation, Compaction Tests – OMC and MDD, shear strength of soil, Triaxial compression test, Unconfined compression test, Direct shear test and Vane shear test.	**4**
V	Cement: Manufacturing, chemical composition, Types, Tests, Hydration of cement. Properties of fresh concrete and hardened concrete. Types of stone masonry – composite walls - cavity walls and partition walls - Construction details and features. Finishing works: Plastering, Pointing, Painting – objectives and types. Prefabricated construction – advantages and disadvantages, Prefabricated building components. Causes of failures in RCC and Steel structures. Types of tenders, Types of contracts. Types of Schedules. Network analysis – CPM, PERT – concepts and problems.	**2**
	Total hours	**15**

vi) Evaluation Pattern:

Written examination : 50 marks
(50 multiple choice questions)

Note: Minimum pass mark for this course is 25 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U38C	TRANSPORTATION ENGINEERING LAB	PCC	0	0	3	2	2020

i) PRE-REQUISITE: CE1U20F TRANSPORTATION ENGINEERING.

ii) COURSE OVERVIEW:

The objective of this course is to enable students to assess the quality of various pavement materials and their suitability in highway construction. The course is designed to make student familiar with mix design and do functional evaluation of pavements.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Analyse the suitability of soil as a pavement subgrade material.	Apply
CO 2	Assess the suitability of aggregates as a pavement construction material.	Apply
CO 3	Evaluate bitumen based on its properties so as to recommend it as a pavement construction material.	Apply
CO 4	Design bituminous mixes for pavement layers .	Apply
CO 5	Evaluate functional adequacy of pavements based on roughness of pavement surface.	Apply

iv) SYLLABUS

1) Test on soil- California Bearing Ratio Test (soaked/unsoaked specimen)

2) Tests on coarse aggregates- Specific Gravity and Water Absorption Test, Aggregate Impact Test.

3) Los Angeles Abrasion Test, Aggregate Crushing Value Test

4) Tests on bitumen.

5) Mix design of bituminous mix.

6) Functional evaluation of pavement.

v) REFERENCES

1) Khanna, S.K., Justo, C.E.G. and Veeraragavan, A., *Highway Materials and Pavement Testing*, Nem Chand & Bros., Roorkee.
2) G. Venkatappa Rao, K. Ramachandra Rao, Kausik Pahari and D. V. BhavannaRao., *Highway Material Testing and Quality Control*, I.K. International.
3) L. R. Kadiyali and N. B. Lal., *Principles and Practices of Highway Engineering,* Khanna Publishers.

vi) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
	Test on soil	
I	California Bearing Ratio Test unsoaked specimen.	3
	California Bearing Ratio Test of soaked specimen.	3
	Test on Coarse Aggregate	
II	Specific Gravity and Water Absorption Test	3
III	Aggregate Impact Test	3
IV	Los Angeles Abrasion Test	3
V	Aggregate Crushing Value Test	3
VI	Shape Test (Angularity number, flakiness index, Elongation index, Combined flakiness and elongation index)	3
VII	Stripping value of road aggregates	3
	Tests on Bitumen	
VIII	Determination of grade of bitumen based on viscosity	3
IX	Softening point	3
X	Ductility of bitumen	3
XI	Flash and fire point of bitumen	3
	Design of Bituminous Mix	
XII	Design of bituminous mix by Marshall method of mix design	6
	Functional Evaluation of Pavement	
XIII	Use of MERLIN apparatus to determine road roughness	3
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	4 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test : 30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U30A	CIVIL ENGINEERING SOFTWARE LAB	Lab	0	0	3	2	2020

i) PRE-REQUISITE: CIVIL ENGINEERING DRAWING, STRUCTURAL ANALYSIS AND DESIGN COURSES, SURVEYING LAB.

ii) COURSE OVERVIEW:

The course aims to train the students to use different software tools needed for professional practice in civil engineering. Also the field expertise needed for undertaking the surveying activity using modern instruments and hence to prepare the necessary engineering documentation are included in this laboratory course.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Analysis and design of multi-storeyed framed structure.
CO 2	Prepare design details of different structural components, implementation plan for a project.
CO 4	Prepare a technical document and scheduling of engineering activities like surveying, structural design and project planning.

iv) SYLLABUS

Analysis and design of steel and RCC elements using any standard software used in the industry. Preparation of structural drawings of slabs and beams. Use of Building Information Modelling tools. Use of Building Information Modelling tools.

v) REFERENCES

1) Raju N. K., Structural Design and Drawing, Second Edition, Universities Press (India), Private Limited, Hyderabad, 2009
2) Reference Manual of the Relevant Software
3) Gopi S, Dr Sathikumar R, Madhu N, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India, 2006
4) AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, US, 2015

vi) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
I	Analysis and design of steel and RCC elements using any standard software used in the industry: Analysis and design of continuous and cantilever beams.	**3**
II	Analysis and design of multi-storied RCC framed structures.	**3**
III	Preparation of structural drawings of slabs and beams: Detailed structural drawing of one way / two way and continuous slabs.	**3**
IV	Detailed structural drawing of continuous / flanged beams.	**3**
V	Detailed structural drawing of foundation units – isolated and combined footing (rectangular).	**3**
VI	Use of Building Information Modelling tools: Introduction to BIM process and describe the workflow in using BIM in the building lifecycle (Theory Discussion).	**3**
VII	Use of Project Management Software (MS Project/Primavera): Introduction to project management - CPM & PERT (Theory class).	**3**
VIII	Preparation of Bar Chart/Gantt Charts/CPM/PERT Charts.	**3**
IX	To find the critical Path based on the given set of activity/event data.	**3**
X	Practice on Resource allocation and Project Monitoring (Cost and Time).	**3**
XI	Field exercise to use Total Station: Field exercise on preparation of contour map for a given terrain using advanced surveying instruments like Total Stations (The survey activity undertaken shall be of at least 5000 Sq. m).	
	Total hours	**30**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test	:	30 marks

PROGRAMME ELECTIVE - I

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31A	ADVANCED COMPUTATIONAL METHODS	PEC	3	0	0	3	2020

I)PRE-REQUISITE: MA0U20DPROBABILITY, STATISTICS AND NUMERICAL METHODS

ii) COURSE OVERVIEW

Goal of this course is to expose the students to different numerical solutions and to impart the ability to apply mathematics for finding solutions to real time problems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the principle of different numerical computational approaches	Understand
CO 2	Solve a system of linear and non-linear algebraic equations having practical relevance.	Apply
CO 3	Apply appropriate data smoothing technique for a given set of data.	Apply
CO 4	Solve ordinary differential equations of boundary value type and partial differential equations in 2D.	Apply
CO 5	Apply the concepts of discretization based solution methods.	Apply

iv) SYLLABUS

Introduction to numerical methods, Errors in numerical computation – System of linear algebraic equations, Elimination methods, Gauss Seidel iteration, Factorization methods. System of non-linear equations, Eigen value problems.

Lagrangian and Hermite interpolation, Spline Interpolation-Quadratic and Cubic splines, Data smoothing by least squares criterion, exponential model and power equation, Multiple linear regression. Numerical integration

Solution of first-order ordinary differential equations, Use of Taylor series, Euler's method, Modified Euler's method, Predictor-corrector method, Runge-Kutta method.

Ordinary differential equations of the boundary value type. Partial differential equations in two-dimension, Elliptic equations, Parabolic equations – Explicit finite difference method –Bender-Schmidt method. Crank-Nicholson implicit method, Finite difference method – Problems with irregular boundaries

Weighted residual methods for initial value problems and boundary value problems. Introduction to FEM- outline of the procedure – Types of 1D, 2D and 3D elements-element properties- polynomial form- shape function form- equilibrium and compatibility in the solution, Conceptual ideas of finite volume, boundary element and meshless methods.

v)(a) TEXT BOOKS

1) Gerald and Wheatly, *Applied Numerical Analysis*, Pearson Education, 7th edition, 2004.
2) Chapra S. C. and Canale R. P., *Numerical Methods for Engineers*, Mc Graw Hill, 7th edition, 2015.
3) Grewal B. S., *Numerical Methods in Engineering and Science*, Khanna Publishers, 11th edition, 2017.
4) Rajasekharan S., *Numerical Methods in Science and Engineering*, S Chand & company, 2nd edition, 2003.

(b) OTHER REFERENCES

1) Smith G. D., *Numerical solutions for Differential Equations*, Mc Graw Hill.
2) Ketter R. L. and Prawel S., *Modern Methods for Engineering Computations,* Mc Graw Hill.
3) Krishnamoorthy C. S., *Finite Element Analysis-Theory and Programming*, Tata McGraw Hill, New Delhi., 2nd edition, 2011.
4) Bathe K. J., *Finite Element Procedures in Engineering Analysis*, Prentice Hall, New Delhi. 2nd edition, 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to numerical methods-Errors in numerical computation – System of linear algebraic equations –Ill-conditioned systems – Symmetric and Banded systems. Elimination methods – Gauss Elimination (review), Gauss Seidel iteration, Factorization method-Choleski's method. System of non-linear equations – Newton-Raphson method. Eigen value problems - largest and smallest eigen values- Power method, Jacobi's transformation.	**8**
II	Lagrangian and Hermite interpolation, Spline Interpolation-Quadratic and Cubic splines (example of equal intervals), Data smoothing by least squares criterion- non-polynomial models like exponential model and power equation, Multiple linear regression. Numerical integration- Newton – Cotes open quadrature formula -Trapezoidal rule, Simpson's rules, Weddle's rule.	**9**
III	Solution of first-order ordinary differential equations-stability of solution, Use of Taylor series, Euler's method, Modified Euler's method, Predictor-corrector method – Milne's method, Fourth order Runge-Kutta method; Higher order equations of initial value type by Runge-Kutta method.	**8**

IV	Ordinary differential equations of the boundary value type – Finite difference solution. Partial differential equations in two-dimension-types, Elliptic equations-Laplace Equation and Poisson's equation, Parabolic equations – Explicit finite difference method –Bender-Schmidt method. Crank-Nicholson implicit method, Finite difference method – Problems with irregular boundaries.	**10**
V	Weighted residual methods for initial value problems and boundary value problems – Collocation method, Subdomain method, Method of least squares, Galerkin's method. Introduction to FEM- outline of the procedure – Types of 1D, 2D and 3D elements- element properties- polynomial form-shape function form- equilibrium and compatibility in the solution- convergence requirements, boundary conditions. Conceptual ideas of finite volume, boundary element and meshless methods.	**10**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31B	GEOTECHNICAL INVESTIGATION	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING I

ii) COURSE OVERVIEW

This course is aimed to provide the students, a clear idea about how a geotechnical investigation program is to be planned and executed. It gives the students an in-depth knowledge of the various methods of geotechnical investigation and the field tests to be conducted in different situations.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the procedure, applicability and limitations of various methods of geotechnical investigation.	Understand
CO 2	Interpret the soil profile data and take appropriate decisions related to geotechnical investigations.	Apply
CO 3	Explain the procedure and applications of penetration tests and geophysical tests for exploration of the soil profile.	Understand
CO 4	Choose the right soil sampling technique and identify the dependability of samples collected.	Apply
CO 5	Describe the procedure and applications of field load tests and rock quality indices.	Understand

iv) SYLLABUS

Introduction and practical importance and objectives of soil exploration: Planning of a sub-surface exploration program- I.S. and other guidelines- Methods of exploration.
Standard Penetration Test: Static Cone Penetration Test– Dynamic Cone Penetration Test – Critical comparison of SPT, static CPT, and dynamic CPT.
Geophysical methods: Seismic refraction method – Electrical resistivity method– Stabilization of boreholes, Groundwater level estimation.
Soil sampling: Undisturbed, disturbed, and representative samples - Handling and transportation of samples –Types of samplers.

Pressure meter test – Flat Dilatometer Test - Plate load test – Rock core sampling–Bore log – Sub-soil investigation report.

(v) (a) TEXT BOOKS

1) Gopal Ranjan and Rao A.S.R., *Basic and Applied Soil Mechanics*, New Age International (P) Limited, New Delhi, 2016.

2) Venkata Ramaiah, *Geotechnical Engineering*, Universities Press (India) Limited, Hyderabad, 2010.

(b) OTHER REFERENCES

3) Arora K.R., *Geotechnical Engineering*, Standard Publishers Distributors, New Delhi, 2019.
4) Joseph E. Bowles, *Foundation Analysis and Design*, Mc. Graw Hill Inc., New York, 2001.
5) Purushothamaraj P., *Soil Mechanics and Foundation Engineering*, Dorling Kindersley (India) Pvt. Ltd., 2013.
6) Terzaghi K. and R. B. Peck, *Soil Mechanics in Engineering Practice*, John Wiley, 1996.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction and practical importance - Objectives of soil exploration– Planning of a sub-surface exploration program – Collection of existing information, reconnaissance, preliminary and detailed investigation.. I.S. and other guidelines for deciding the number, size, spacing, and depth of boreholes Methods of exploration - Open pits – Auger boring- -Wash boring, percussion drilling, rotary drilling.	9
II	Standard Penetration Test – Procedure –corrections to be applied to observed N values – Numerical examples -Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test – Correlations of N value with various engineering and index properties of soils. Static Cone Penetration Test – Procedure – Merits/drawbacks – Correlation of static CPT results with soil properties -Dynamic Cone Penetration Test – Brief Procedure – Merits/drawbacks –Critical comparison of SPT, static CPT, and dynamic CPT.	9
III	Geophysical methods – Seismic refraction method – Procedure, uses, limitations – Solution of numerical problems to estimate the velocity of seismic waves and the thickness of the upper layer of a two-layered soil system - Electrical resistivity method – Electrical profiling and electrical sounding – Procedure, uses, limitations. Stabilization of boreholes, Groundwater level estimation.	9
IV	Soil sampling – Undisturbed, disturbed, and representative samples –Chunk and tube samples – Factors affecting sample disturbance and methods to minimize them –Area ratio - Inside clearance – Outside clearance - Recovery ratio –Ball check valve – Numerical Problems - Handling and transportation of samples – Extrusion of samples. Types of samplers – Thin-walled sampler – Piston sampler – Split spoon sampler – Methods for collection of sand samples from beneath the water table - Core retainers.	9

V	Pressure meter test - Procedure –Uses – limitations, Flat Dilatometer Test (Brief only)Plate load test – Procedure, uses, and limitations – modulus of subgrade reaction- Solution of numerical problems using plate load test data. Rock core sampling, Rock Quality Designation, Core Recovery Ratio – Bore log – Soil profile – Sub-soil investigation report.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31C	TRAFFIC ENGINEERING AND MANAGEMENT	PEC	2	1	0	3	2020

i) PRE-REQUISITE: CE1U20F TRANSPORTATION ENGINEERING.

ii) COURSE OVERVIEW

The objective of this course is to impart in-depth knowledge pertinent to traffic flow theory, traffic management measures, capacity analysis, design of road intersections and road safety**.**

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Discuss the relationship among various traffic stream variables.	Understand
CO 2	Apply traffic management measures and regulations to solve issues related to traffic flow in our road network.	Apply
CO 3	Explain the concept of capacity and LOS and its estimation for various traffic facilities.	Understand
CO 4	Discuss the need for intersection control and design of various types.	Apply
CO 5	Outline the causes of road accidents and suggest preventive measures .	Understand

iv) SYLLABUS

Traffic Flow Characteristics: *Fundamental Parameters*- speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation. Fundamental diagrams of traffic flow.

Traffic stream models: Single Regime models - Greenshields model, Greenberg logarithmic model, Multi-regime models – Two and three regime linear models.

Regulation of Traffic – Need and scope of traffic regulations- Motor Vehicle Act – Regulation of speed- Regulation of vehicles – Regulations concerning driver- General rules concerning traffic- parking regulations- Enforcement of regulations.

Traffic Management – scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-Closing side streets –Exclusive bus lanes.

Capacity and Level of service (LOS): Concept- Base capacity, adjusted capacity, LOS definition, Factors affecting Capacity and LOS, Homogeneous and heterogeneous traffic conditions-vehicle types - Concept of PCU.Capacity and LOS analysis –Single lane, Intermediate lane and two lane interurban roads- Base capacity and adjustment factors- Indo HCM (2017) Guidelines

Capacity and LOS analysis of Urban roads - Base conditions- Adjustment factors- Indo HCM (2017) Guidelines.

Intersections: At-grade intersections- basic forms- conflict points -visibility triangle- design principles- Channelization. Roundabouts- Geometric layout, types- design elements.

Traffic Signals –Warrants- pre-timed and traffic actuated. Design of signal timing at isolated intersections- Phase design-optimum cycle time (Webster’s approach), green splitting- pedestrian phase -phase diagrams, timing diagram.

Grade separated intersection: Grade separated intersections without interchange and with interchange- Three leg interchange, Four leg interchange and multi-leg interchange.

Traffic Control Measures - Traffic Signs, Road Markings, and Traffic control aids.

Traffic Safety: Road Safety Situation in India, Causes of road accidents – influence of road, vehicle, driver and environmental factors - Pedestrian Safety, Collection and statistical analysis of accident data, Collision and condition diagram.

Road Safety Audit- concept and need- organizations involved- stages of road safety audit (brief description only)

v) (a) TEXT BOOKS

1) Kadiyali L.R. *Traffic Engineering and Transport Planning*, Khanna Publishers, 9th Edition, 2011
2) Khanna S.K and Justo C.E.G; *Highway Engineering*, Nem Chand Publishers, 10th Edition,2018.
3) CAO’ Flaherty, *Transport Planning and Traffic Engineering*, Elsevier, 2006.

(b) OTHER REFERENCES

4) Roger P. Roess, William R. Mc Shane & Elena S. Prassas, Traffic Engineering, 5th edition, Prentice-Hall, 2019.
5) Pignataro L. J., Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
6) C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice- Hall India, 3rd Edition, 2002.
7) P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India, 2nd Edition, 2017.
8) A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
9) C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 3rd Edition, 2015.
10) Highway Capacity Manual (HCM), Transportation Research Board, USA, 2010.
11) Indian Highway Capacity Manual (Indo-HCM), CSIR, New Delhi, 2017.
12) IRC SP:088 2019 Manual on Road Safety Audit
13) IRC 35:2015 Code of Practice for Road Markings (Second Revision)
14) IRC 65:2017- Guidelines for the Planning and Design of Roundabouts (First Revision)
15) IRC 93:1985 *Guidelines on Design and Installation of Road Traffic Signals.*

vi) COURSE PLAN

Module	Contents	No. of hours
I	Fundamental parameters- speed density, volume, travel time, headway, spacing, time-space diagram, time mean speed space mean speed and their relation. Fundamental Diagrams of Traffic Flow. Single regime Model- Greenshield, Greenberg logarithmic model. Multi- regime Models-Two and three regime Linear Models.	8
II	Need and scope of traffic regulations-Motor Vehicle Act-Regulation of speed-Regulation of vehicles-Regulations concerning the driver-General rules concerning the traffic-parking regulations-Enforcement of regulations. Scope of traffic management measures-restrictions to turning movements-one-way streets-tidal flow operations-Closing side streets –Exclusive bus lanes.	8
III	Capacity and Level of Service: concept-Base Capacity, Adjusted capacity, LOS definition, Factors affecting Capacity and LOS, Homogeneous and Heterogeneous traffic conditions-vehicle types, concept of PCU. Capacity and LOS analysis –Single lane, Intermediate lane and two lane interurban roads-Base capacity and adjustment factors -IndoHCM (2017)Approach. Capacity and LOS analysis of urban roads - Base conditions- Adjustment factors-IndoHCM (2017) Approach.	10
IV	Intersections: At-grade intersections-basic forms- conflict points -visibility triangle- design principles Channelization. Roundabouts- Geometric layout, types- design elements. Traffic Signals - Warrants- pre-timed and traffic actuated. Design of signal timing at isolated intersections- Phase design- optimum cycle time (Webster’s approach), green splitting- pedestrian phase- phase diagrams, timing diagram. Grade separated intersection: Grade separated intersections without interchange, and with interchange- Three leg interchange, Four leg interchange and multileg interchange. Traffic Control Measures - Traffic Signs, Road Markings, Traffic control aids.	11
V	Traffic Safety: Road Safety Situation in India, Causes of road accidents – influence of road, vehicle, driver and environmental factors - Pedestrian Safety, Collection and statistical analysis analysis of accident data, Collision and condition diagram, Road safety audit- concept and need- organizations involved stages of road safety audit (brief description only).	8
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31D	MECHANICS OF FLUID FLOW	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U20B FLUID MECHANICS AND HYDRAULICS

ii) COURSE OVERVIEW

Goal of this course is to impart to the students the knowledge of fundamentals of fluid flow and to develop the skill for applying the fluid flow concepts in flow through pipes and open channels for solving civil engineering problems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply the principles of potential flow and viscous flow.	Apply
CO 2	Solve the problems of turbulent flow through pipes and pipe bends by recollecting the relevant hydraulic principles.	Apply
CO 3	Apply the principles and laws governing fluid flow to flow in open channels.	Apply
CO 4	Demonstrate the basic modeling laws in fluid mechanics and dimensional analysis.	Apply

iv) SYLLABUS

Fluid flow: Types of fluid flow (Review) Potential flow-velocity potential, stream function, streamlines and equipotential lines, flow net-uses and limitations. Viscous flow – Reynold’s experiment; Shear stress – pressure gradient relationship – Laminar flow through pipes (Hagen-Poiseuille Equations), laminar flow between stationary parallel plates.

Turbulent flow – Computation, velocity distribution, Head loss due to friction in pipes – Nikuradse experiment with artificially roughened pipe. Friction coefficient for laminar and turbulent flows, Moody’s diagram, reduction of carrying capacity of pipes with age. Hazen William’s formula. Flow through pipe bends – application of linear momentum principle.

Open channel flow – Hydraulic exponents and section factor for uniform and critical flow, Pressure distribution in curvilinear flows – spillway crest and spillway bucket. Comparison of discharge through compound channels. Application of Specific energy for channel transitions – hump and reduction in channel width.

Rapidly varied steady flow – hydraulic jumps – types based on tail water conditions; Uses of hydraulic jumps for energy dissipation below spillways – jump height curve; tail water curve. Unsteady flow through open channels – Surges – positive surges (problems) and concept of negative surges; Transients in pipes – water hammer.

Experimental hydraulics – Physical modelling – Dimensional analysis – Rayleigh's method, Buckingham's pi – theorem, Similitude, Model laws for viscous and open channel flows – Reynold's and Froude's model law; Scale effect, distorted and undistorted models.

(v) (a) TEXT BOOKS

1) Modi P.N. and S.M. Seth, *Hydraulics & Fluid Mechanics*, S.B.H Publishers, New Delhi, 2019.
2) Subramanya K., *Flow in Open Channels*, Tata McGraw Hill, 2019.
3) Streeter, V. L. and Wylie, E. B., *Fluid Mechanics*, McGraw Hill, 7th edition, 2010.

(b) OTHER REFERENCES

4) Bansal R. K., *A textbook of Fluid Mechanics and Hydraulic Machines*,Laxmi Publications,2018.
5) Frank M. White, *Fluid Mechanics*, McGraw Hill, 2017.
6) Bruce R Munson, Donald F Young. *Fundamentals of Fluid Mechanics*, John Wiley & Sons, 2011.
7) Arora K. R. Fluid Mechanics, *Hydraulics and Hydraulic Machines*, Standard Publishers, 2020.
8) Mohanty A.K. *Fluid Mechanics*, Prentice Hall, New Delhi, 2011.
9) Narayana Pillai, N. *Principles of Fluid Mechanics and Fluid Machines*, University Press, 2011.
10) Kumar D.N. *Fluid Mechanics and Fluid power Engineering*, S. K. Kataria & sons, 2013.
11) Pijush K. Kundu, Ira M. Cohen, David R. Dowling, *Fluid mechanics*, Academic press, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Fluid flow: Types of fluid flow (Review) Potential flow-velocity potential, stream function, streamlines and equipotential lines, flow net-uses and limitations. Viscous flow – Reynold's experiment; Shear stress – pressure gradient relationship – Laminar flow through pipes (Hagen-Poiseuille Equations), laminar flow between stationary parallel plates.	9
II	Turbulent flow – Computation, velocity distribution, Head loss due to friction in pipes – Nikuradse experiment with artificially roughened pipe. Friction coefficient for laminar and turbulent flows, Moody's diagram, reduction of carrying capacity of pipes with age. Hazen William's formula. Flow through pipe bends – application of linear momentum principle.	10
III	Open channel flow – Hydraulic exponents and section factor for uniform and critical flow, Pressure distribution in curvilinear flows –	9

	spillway crest and spillway bucket. Comparison of discharge through compound channels. Application of Specific energy for channel transitions – hump and reduction in channel width.	
IV	Rapidly varied steady flow – hydraulic jumps – types based on tail water conditions; Uses of hydraulic jumps for energy dissipation below spillways – jump height curve; tail water curve. Unsteady flow through open channels – Surges – positive surges (problems) and concept of negative surges; Transients in pipes – water hammer.	**9**
V	Experimental hydraulics – Physical modelling – Dimensional analysis – Rayleigh's method, Buckingham's pi – theorem, Similitude, Model laws for viscous and open channel flows – Reynold's and Froude's model law; Scale effect, distorted and undistorted models.	**8**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31E	ADVANCED CONCRETE TECHNOLOGY	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30E CONSTRUCTION TECHNOLOGY AND MANAGEMENT

ii) COURSE OVERVIEW

This course is aimed at exposing the students to the fundamentals of properties of concrete materials, its testing procedures, various types of concretes, NDT of concrete and mix design. After this course, students will be in a position to determine the properties of concrete materials, testing of concrete and do a mix design based on requirement.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Recall the properties and testing procedure of concrete materials as per IS code and describe the rheology of concrete.	Remember
CO 2	Design concrete mix using IS Code Methods.	Apply
CO 3	Describe the procedure of determining the properties of fresh and hardened concrete.	Understand
CO 4	Summarise the different non-destructive testing of concrete.	Understand
CO 5	Describe the various special types of concrete.	Understand

iv) SYLLABUS

Cement, Aggregate, Chemical Admixtures, Mineral admixtures, Rheology, Bingham model.
Mix design, design of concrete mix as per IS 10262-2019, Statistical quality control of concrete.
Properties of fresh concrete, Properties of hardened concrete, Creep, Shrinkage.
Durability of concrete, Non-destructive testing of concrete surface hardness test.
Special concretes, Special processes and technology.

v) (a) TEXT BOOKS

1) Neville A.M., *Properties of Concrete*, Trans-Atlantic Publications, Inc., 5e, 2016.
2) R. Santhakumar, *Concrete Technology*, Oxford Universities Press, 2018,
3) Shetty M. S., *Concrete Technology*, S. Chand & Co., 2018.

(b) OTHER REFERENCES

1) Mehta and Monteiro, *Concrete-Micro structure, Properties and Materials,* Mc-Graw Hill Professional 2017.
2) Neville A. M. and Brooks J. J., *Concrete Technology,* Pearson Education, 2019.
3) Lea, *Chemistry of Cement and Concrete*, Butterworth-Heinemann Ltd, 5e, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Cement -Review of manufacturing process- chemical composition, Bogue's compounds, mechanism of hydration-heat of hydration-Aggregate-Review of types, sampling and testing, artificial aggregates - Chemical Admixtures- types, uses, mechanism of action - effects on properties of concrete - Mineral admixtures-types, chemical composition - physical characteristics - effects on properties of concrete - Rheology – basic concepts – Bingham model	9
II	Mix design - nominal mix- design mix – concept of mix design - variables of proportioning - general considerations - factors considered in the design of concrete mix- various methods of mix design - design of concrete mix as per IS 10262-2019 - Statistical quality control of concrete – mean strength – standard deviation – coefficient of variation – sampling - testing - acceptance criteria	9
III	Properties of fresh concrete- workability-factors affecting workability - slump test compaction factor test- Vee Bee consistometer test- Properties of hardened concrete - modulus of elasticity, compressive strength, split tensile strength, flexural strength- effect of water cement ratio – maturity concept- Creep - factors affecting creep - effect of creep. Shrinkage- factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.	9
IV	Durability of concrete- Factors affecting durability - permeability-cracking-reinforcement corrosion; carbonation, chloride penetration, sulphate attack, acid attack, fire resistance; frost damage, alkali silica reaction, concrete in sea water - Non-destructive testing of concrete surface hardness test- ultrasonic pulse velocity method - penetration resistance- pull-out test core cutting - measuring reinforcement cover.	9

V	Special concretes - lightweight concrete-heavy weight concrete - high strength concrete – high performance concrete - self compacting concrete -roller compacted concrete– fibre reinforced concrete - polymer concrete-pumped concrete - ready mixconcrete - green concrete. Special processes and technology - sprayed concrete; underwater concrete, mass concrete; slip form construction, prefabrication technology- 3D concrete printing	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31F	ENVIRONMENTAL IMPACT ASSESSMENT	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

The goal of this course is to introduce students to the methodologies for identifying, predicting, evaluating and mitigating the impacts on environment due to any developmental project or activities. The course also helps the students to prepare an impact assessment report and devise an environment management plan. Sufficient background will be provided on the environmental clearance procedures in India.

iii) COURSE OUTCOMES

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

CO 1	Explain the need for minimizing the environmental impacts of developmental activities	Understand
CO 2	Discuss the various environmental legislations and clearance procedure in the country	Understand
CO 3	Apply various methodologies for assessing the environmental impacts of any developmental activity	Apply
CO 4	Prepare an environmental audit and environmental impact assessment report	Apply

iv) SYLLABUS

Definition, Need for EIA, Evolution of EIA- Environmental legislations in India- Environmental standards for water, air and noise quality- EIA Notification 2006.

Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal- Form1- Category of projects- Generic structure of EIA report- Terms of Reference (ToR)- Types of EIA- Initial Environmental Examination (IEE).

EIA methodologies-Impact prediction, Evaluation and mitigation-Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment- Assessment of ecological impacts and socio-economic impacts.

Environmental Management Plan (EMP)- Environment Audit- ISO 14001 standards- Importance, Salient features - Stages in implementation- Benefits.

EIA case studies (Indian)- a highway project, a hydro-electric power plant, an airport project, a quarry mining project and a solid waste management project.

v) (a) TEXT BOOKS

1) Canter, L. W., *Environmental Impact Assessment*, McGraw Hill Inc., New York, 1996.
2) Anjaneyulu, Y., *Environmental Impact Assessment Methodologies*, B. S. Publications, Hyderabad, 2020.
3) Marriott, B.B., *Environmental Impact Assessment: A Practical Guide,* McGraw Hill Professional, 1997.

(b) OTHER REFERENCES

4) Glasson, J. and Therivel, R., *Introduction to Environmental Impact Assessment*, Routledge Publications, Fifth Edition ,2019.
5) Lawrence, D. P., *Environmental Impact Assessment (Practical Solutions to Recurrent Problems),* Wiley International, New Jersey, 2003.
6) Ministry of Environment and Forests, Govt. of India, *EIA Notification*, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition, Need for EIA, Evolution of EIA: Global and Indian Scenario-Environmental legislations in India- The Water(Prevention and Control of Pollution) Act 1974, The Air (Prevention& Control of Pollution) Act 1981, The Environmental (Protection) Act 1986- Environmental standards for water, air and noise quality- EIA Notification 2006.	9
II	Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal- Form1- Category of projects- Generic structure of EIA report- Terms of Reference (ToR)- Types of EIA: Strategic, Regional, Sectoral, Project level- Rapid EIA and comprehensive EIA- Initial Environmental Examination (IEE).	9
III	EIA methodologies: Ad hoc, checklist, matrix, network and overlay- Impact prediction, Evaluation and mitigation-Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment- Assessment of ecological impacts and socio- economic impacts.	9
IV	Environmental Management Plan (EMP): Goal and purpose- Importance of EMP- Content of an EMP- Role of environmental monitoring program. Environment Audit: Need for audit- Audit types and benefits- Environmental audit procedure. ISO 14001	9

	standards: Importance, Salient features - Stages in implementation-Benefits.	
V	EIA case studies (Indian)- A highway project, A hydro-electric power plant, An airport project, A quarry mining project and a solid waste management project.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U31G	FUNCTIONAL DESIGN OF BUILDINGS	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30E CONSTRUCTION TECHNOLOGY AND MANAGEMENT

ii) COURSE OVERVIEW

The general objective of this course is to provide an insight to the students to various aspects of functional design of buildings and innovative construction methods.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain basic principles of acoustics, and noise control techniques.	Understand
CO 2	Describe design standards of Lighting and artificial lighting designs.	Understand
CO 3	Discuss the principles involved in the design of buildings for thermal comfort and influence of climate on design of buildings.	Understand
CO 4	Summarize the basic concept of electrical load calculation, plumbing design, HVAC load Calculation, functioning of elevators and escalators and rough cost estimation.	Understand
CO 5	Explain the innovative construction concepts	Understand

iv) SYLLABUS

Acoustical / Sonic Environment and acoustical comfort, Reflection of sound and their applications, Basic design of the elements for the required degree of sound insulation- Air and structure born noises-equivalent noise levels-day and night equivalent, Acoustical defects- acoustical considerations for design.

Natural lighting, The sky as a source of light, Design of side-lit windows-BIS and CBRI methods skylights Artificial lighting, Design of artificial lighting, Basic idea of street lighting and outside lighting.

Thermal comfort, Earth-Sun relationship, Solar angles, Computation of solar radiation on different surfaces, Thermo physical properties of building materials and thermal control, Climate conscious designs, Thermal insulation.

Functional elements: Concept for electrical load calculation of structures, Basic concept of functioning of elevators and escalators, Causes of fire and Mechanism.

Functionality as per Vastusastra, Innovative concepts of functionality, Concepts of Intelligent building.

v) (a) TEXT BOOKS

1) Knudsen V.O. and Harris C.M., *Acoustical Design in Architecture*, John Wiley, 1980.
2) M David Egan, *Architectural Acoustics,* J. Ross Publishing, 2007.
3) Marshall Long, *Architectural Acoustics*, Second Edition, Academic Press, Waltham, USA, 2014.
4) Bureau of Indian standards, *Handbook on Functional Requirement of Buildings* – SP: 41(S and T)-1987.
5) Pritchard, D.C., *Lighting*, Longman Scientific & Technical, Harlow,1995.
6) Benjamin Evans, *Daylight in Architecture*, McGraw - Hill Book Company, New York, 1981.
7)Koenigseberger, *Manual of tropical Housing and Building* Part I – Climatic design, Orient Longman, 2011.

(b)OTHER REFERENCES

8) Ajitha Simha.D, *Building Environment*, Tata McGraw Hill Publishing Co., New Delhi, 1985.
9) Jain. V.K., *Design and Installation of Services in Building complexes & High Rise Buildings*, Khanna Tech. Publishers, New Delhi, 1986.
10) *National Building Code of India* (NBC2016)
11) Wayne Forster and Dean Hawkes, *Energy Efficient Buildings: Architecture, Engineering, and Environment*. W.W. Norton Company Inc.2002.
12) Bureau of Energy Efficiency, India. *Design Guidelines for Energy Efficient Multi-Store Buildings*, 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Acoustical / Sonic Environment and acoustical comfort: Sound, Nature of sound- Behavior of sound in enclosed spaces-Concept of Geometric Acoustics-Reflection of sound and their applications-Absorption of sound-Sound absorption coefficient-Human Audibility rangeReverberation& Reverberation Time Calculation-Flanking paths- Sound absorption-materials and fixings-Reverberation-Sabine's formula-Eyrings modification.-Basic design of the elements for the required degree of sound insulation- Air and structure born noises-equivalent noise levels-day and night equivalent. Acoustics, applications: Measures of noise control-Source-path and receiving end. TL value and computation of TL value, Acoustical defects- acoustical design of auditoriums and small lecture halls-Acoustical considerations of offices, hospitals and Industrial buildings.	9

II	Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings, Standards of Lighting and Visual comfort-The sky as a source of light, Daylight factor, Daylight penetration-Calculation of daylight factor. Design of side-lit windows-BIS and CBRI methodsskylights Artificial lighting: Artificial lighting-illumination requirements-lux meter – lamps and luminaries – polar distribution curves– Color temperature and color rendering index-glare - Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting	**9**
III	Thermal comfort: Factors affecting thermal comfort- effective temperature- thermal comfort indices-ET-CET Charts- Bioclimatic chart- Psychrometry and Psycrometric chart. Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar anglesComputation of solar radiation on different surfaces-solar path diagram-shadow-throw concept and design of shading devices Thermal design of buildings: Thermo physical properties of building materials and thermal control: passive and active building design- Steady and periodic heat flow through building envelope. Design approaches: Climate conscious designs- Climatic zones in India- orientation and shape of buildings in different climatic zones-Passive solar-Active solar and Active approaches. Requirements of buildings in tropical areas-Thermal insulation	**9**
IV	Functional elements: Concept for electrical load calculation of structures- basic criteria for plumbing design – basic concept of HVAC load calculation – Basic concept of functioning of elevators and escalators- basic cost estimation. Functional protection: Causes of fire, Mechanism of fire spread in buildings, classification of fire-High temperature effects and combustibility of building materials and structure- Fire alarm system, and means of escape-Firefighting installations.	**9**
V	Functionality as per Vastusastra: Basic concepts- Governing criteria of functionality- Energy pattern- understand traditional techniques in Tropical climate with vernacular buildings in Kerala as case study. Innovative concepts of functionality: Concept of green building-case studies on low energy and green buildings-Concepts of Intelligent building- Thirsty concrete- Blue roads- self healing concrete	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

SEMESTER – VII

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U40A	DESIGN OF STEEL STRUCTURES	PCC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30F STRUCTURAL ANALYSIS II

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts in the design of steel structures adhering to codal provisions and enable them to recognize and solve practical problems in the area.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the properties of structural steel to resist various structural forces and the design approaches.	Understand
CO 2	Apply the codal provisions to compute the design strength and requirements of joints in structural steel connections.	Apply
CO 3	Examine the design of structural steel members subjected to tensile, compressive and flexural forces.	Analyse
CO4	Analyse the truss members subjected to wind loads.	Analyse

iv) SYLLABUS

Introduction to steel and steel structures- Introduction to design: Design loads and load combinations, limit state design concepts. Connections; Tension members; Compression members- column bases; Design of beams-Plate girders; Design of roof trusses, Moment resistant/Eccentric connections (in plane and out of plane) Fire resistant design.

v) a) TEXT BOOKS

1) Duggal S. K., *Design of Steel Structures*, McGraw Hill Education India, 2nd edition, 2017
2) Ramchandra S. and Virendra Gehlot, *Design of Steel Structures*, Vol. II, Standard Book House, 2007.
3) Punmia B. C., Jain A. K. and Jain A. K., *Design of Steel Structures*, Laxmi Publications (P) Ltd, 2nd edition 2017.
4) Ramamrutham S., *Design of Steel Structures*, Dhanpath Rai Publishing company, 6th edition, 2016.

b) REFERENCES

1) Subramanian N., *Steel Structures*, Oxford Publication, 2018.
2) Dayaratnam P., *Design of Steel Structures* , S Chand Publishing, 1st edition, 2012.

3) Raghupathi, *Steel Structures*, Tata McGraw Hill, 2006.
4) Shah V. L. and Veena Gore, *Limit State Design of Steel Structures*, Structures Publications, 2009.
5) IS 800 : 2007, *General Construction in Steel- Code of practice*, Bureau of Indian Standards, New Delhi, 2007.
6) IS 875 (Part 3) : 2015, *Code of practice for design loads (Other than earthquake) for Buildings and Structures, Part:3 Wind loads*, Bureau of Indian Standards, New Delhi, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to steel and steel structures-Properties of structural steel and types of Structural steel sections-Introduction to design-design philosophies- Design loads and load combinations Connections: Bolted-different types-joints (lap joint, butt joint) - eccentric loaded connections-beam to beam connections Connections: Welded-different types-joints (lap joint, butt joint) - eccentric loaded connections-beam to beam connections	9
II	Introduction to Tension members - Types of tension members-Modes of failure-Factors affecting strength of tension members-Design of tension members-Concept of shear lag- Application of lug angle- Connections in tension members	9
III	Compression members- Classification-Behaviour Design of struts Solid and built-up columns for axial loads Design of lacing and battening system Column base plate- Simple slab base plate and gusseted base plate under axial load	9
IV	Beams- design of Laterally restrained beams and unrestrained beams Design of simple and compound beams Plate girder design for welded connection Design of stiffeners- end bearing and intermediate stiffeners Gantry girders and beam-column (concept)	9
V	Type of roof truss- design loads and load combinations Calculation of wind loads Design of purlins Moment resistant and eccentric connections-in plane and out of plane (Concepts)	9

	Fire resistance criterion- Fire resistance assessment of steel structure- material property at elevated temperature- design approaches and tools- different models-methods-procedures Passive protection-fire performance assessment	
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

PROGRAMME ELECTIVE - II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41A	PRESTRESSED CONCRETE	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30 A STRUCTURAL ANALYSIS I, CE1U30B DESIGN OF CONCRETE STRUCTURES

ii) COURSE OVERVIEW:

Goal of this course is to make students familiar with the concepts and design of pre-stressed concrete structural elements according to the codal provisions.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the principles, concepts and analysis of prestressed concrete members.	Understand
CO 2	Apply the codal provisions to estimate the deflections of prestressed concrete members.	Apply
CO 3	Examine the design of prestressed concrete members subjected to flexure, shear and torsion.	Analyse
CO 4	Solve statically indeterminate prestressed concrete structures.	Apply
CO 5	Make use of relevant techniques for the analysis of composite prestressed and in situ concrete structures.	Apply

iv) SYLLABUS

Basic concept and principles of pre-stressed concrete -Analysis of prestress- Losses in prestress Design for flexure- Design for shear and torsion-Short and long term deflection of uncracked and cracked members-Transfer of prestress- Transmission of prestressing force by bond in pretensioned members - end zone reinforcement. Anchorage zone stresses in post-tensioned members-Prestressing of statically indeterminate structure-Composite construction.

v) (a) TEXT BOOKS

1) Krishna Raju N., *Prestressed Concrete*, Tata McGraw Hill Publishing Co. New Delhi 2018.
2) Praveen Nagarajan, *Prestressed Concrete*, Pearson Education India, 2013.
3) Dayaratnam P., *Prestressed Concrete*, Tata McGraw Hill Publishing Co. New Delhi, 2017.
4) Sinha N. C. and Roy S. K., *Fundamentals of Prestressed Concrete*, S. Chand & Co., 2011.

5) Rajagopalan N., *Prestressed Concrete*, Narosa Publishing House, New Delhi, 2010.

(b) REFERENCES

1) IS 1343 : 2012, Prestressed Concrete-Code of Practice , Bureau of Indian Standards, New Delhi, 2012.

2) Mallick S. K. and Rangaswamy M. S., *Mechanics of Prestressed Concrete Design*, Khanna
Publishers, 2014.

3) F.K. Hong and R.H. Evans., Reinforced and Prestressed Concrete " Tata McGraw Hill Co. Pvt. 9Ltd., 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Basic concept and principles of pre-stressed concrete; Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel. Advantages of prestressed concrete over reinforced concrete, Different prestressing systems. Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple, Load balancing concept for extreme fiber stresses for various tendon profile. Losses of Prestress: Stages of losses, Types of losses in pre-tensioning and post-tensioning. Losses due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. Loss of pre-stress Stresses at transfer and service loads.	9
II	Flexural strength: - Codal provision for Limit state design, Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force, and Eccentricity. Limiting zone for prestressing force. Shear Resistance of PSC members: - Shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked. Design for shear using IS code. Torsional Resistance of PSC members: - Pure torsion, Combined bending moment and torsion. Combined bending moment, shear and torsion modes of failure. Design of torsion reinforcement using IS code provision.	9
III	Design of Pretensioned and Post-Tensioned Flexural Members: Dimensioning of Flexural members, Estimation of Self Weight of Beams. Design of Pre tensioned and Post tensioned members symmetrical about vertical axis.	9

	Deflections of prestressed concrete members: Importance, factors. Short term deflections. Long term deflection. Codal provisions.	
IV	Transfer of Prestress in Pretensioned members - Introduction Transmission length, Bond stresses. Transverse Tensile Stresses, End-Zone reinforcement. Flexural bond stresses. Anchorage zone Stresses in post tensioned members: Stress distribution in end block, Methods of investigation. Anchorage zone reinforcements, Design (IS Code method only)	**9**
V	Prestressing of statically indeterminate structures: Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments. Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile and its determination. Design of Continuous Prestressed beams. Composite construction of Prestressed and in situ Concrete: Types of composite construction Composite construction: Analysis of stresses, Flexural Strength.PSC Slabs - Types, Design and analysis of PSC One-way Slabs. Design and analysis of PSC two-way slabs	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41B	GROUND IMPROVEMENT TECHNIQUES	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING I and CE1U30C GEOTECHNICAL ENGINEERING II

ii) COURSE OVERVIEW

Goal of this course is to introduce students to various types of ground improvement techniques that can be adopted in different conditions. It enables the students to choose the suitable ground improvement techniques to be adopted, depending on the site condition and requirements.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Classify different ground improvement methods based on the soil suitability and sustainability.	Understand
CO 2	Outline the construction procedure of different ground improvement methods.	Understand
CO 3	Choose different application of geosynthetics in Ground improvement.	Apply
CO5	Apply the principles of soil stabilization for ground improvement.	Apply

iv) SYLLABUS

Role of ground improvement in foundation engineering - Brief introduction to sustainable method of ground improvement - Insitu Densification process - dynamic methods - dewatering - earth reinforcement - Use of Geosynthetics - Grouting techniques- Thermal method - Soil stabilization.

v) a) TEXT BOOKS

1) M. P. Moseley and K. Krisch , Ground Improvement, II Edition, Taylor and Francis, 2006
2) P .Purushothamaraj., Ground Improvement Techniques, Laxmi Publications (P) Ltd, 2021.

b) REFERENCES

1) Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.
2) K. Krisch & F. Krisch , Ground Improvement by Deep Vibratory Methods, Spon Press, Taylor and Francis, 2010.

3) Xianthakos, Abreimson and Bruce, Ground Control and Improvement, John Wiley & Sons, 1994.
4) Koener, R.M, "Designing with Geosynthetics", Prentice Hall, New Jersey, 1994.
5) Manfred R. Hausmann, Engineering Principles of Ground Modification, Mc.Graw Hill, 1989.
6) Jones C. J. F. P., "Earth Reinforcement and soil structures", Butterworths, London, 1985.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Role of ground improvement in foundation engineering – Classification of ground improvement methods- differentproblematic soil- selection of suitable ground improvement based on the soil condition- Emerging trends in ground improvement- different materials used for ground improvement and its properties Brief introduction to sustainable method of ground improvement, microbial methods.	6
II	In situ densification- deep compaction and shallow compaction, properties of compacted soil and compaction control. Dynamic compaction- procedure- design considerations, soil suitability, merit and demerit. Vibration methods-vibro compaction techniques-blasting, vibrating compactors. Vibro displacement methods- vibro flotation sand pile, stone column, lime pile- principle, installation procedure, basic design considerations, soil suitability, merits and demerits.	8
III	Drainage methods- methods of dewatering systems- open sump, well points, vacuum and electro-osmotic methods. Drains-type- drainage facility after construction- foundation drain, blanket drain, interceptor drains. Precompression and vertical drains – preloading, vertical drain-general principle, soil suitability, type- sand drain, PVD installation procedure.	7
IV	Earth reinforcement- reinforcement materials- reinforced earth wall-design considerations- construction procedure. Soil nailing and micro pile- basic concept- construction sequence-areas of application- design considerations- merit and demerit.	7

	Geosynthetics- use, type- function. Filtration, drainage, separation – applications of geotextile in different works	
V	Grouting techniques- grouting material- groutablitiy- stablisation with cement, lime and chemicals. Classification of grouting techniques- particulate grouting, compaction grouting, penetration grouting, jet grouting, displacement grouting- procedure- soil suitability- merit and demerit. Thermal method- stabilization by heating, stabilization by cooling Soil stabilization- fundamental concept of soil- cement stabilization, mechanism of lime stabilization.	8
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41C	HIGHWAY MATERIALS AND DESIGN	PEC	3	0	0	3	2020

i) PRE-REQUISTE- Nil

ii) COURSE OVERVIEW

The course focuses on the characterization of various highway materials, tests on highway materials and the design of bituminous mixes. The course also deals with the analysis and design of highway pavements, both flexible and rigid.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the suitability of conventional as well as marginal materials for the construction of different types of pavements.	Understand
CO 2	Apply appropriate test methods to characterize materials and compute traffic for the design of flexible and rigid pavements.	Apply
CO 3	Apply Marshall method to design bituminous mixes.	Apply
CO 4	Apply the fundamental concepts of stress distribution in a pavement system to estimate the critical stresses and strains.	Apply
CO 5	Make use of Indian standard specifications to design flexible and rigid pavements.	Apply

iv) SYLLABUS

Introduction to highway pavements, desirable properties and testing of road aggregates; Soil – aggregate mixes, alternate materials for durable pavements - Artificial aggregates. Testing of subgrade soil, sub-base, base course materials.

Desirable properties and testing of bitumen, emulsion, cutback and modified binders, aging of bitumen and aging tests.

Analysis of traffic for pavement design.

Design of bituminous mixes by Marshall and Superpave methods.

Stresses and deflections in homogeneous masses, Burmister's 2-layer and 3-layer theories.

Flexible pavement design - CBR and IRC method of flexible pavement design.

Analysis and design of rigid pavements - Warping stresses, Frictional stresses, Combined stresses. Joints in cement concrete pavements, IRC method of design.

v) TEXT BOOKS

1) Justo C E G, Veeraragavan A and Khanna S K, *Highway Engineering*, Nem Chand Publishers, Revised 10th edition, 2018.
2) Huang Y H, *Pavement Analysis and Design*, Prentice Hall, 2nd edition, 2008.

vi) REFERENCES

1) Atkins H N, *Highway Materials, Soils and Concretes*, Pearson Prentice Hall, 4th edition, 2002.
2) Kadiyali L R, *Highway Engineering*, Khanna Book Publishing Co. (P) Ltd., 1st edition (Revised), 2019.
3) IRC: 37-2018, *Guidelines for the Design of Flexible Pavements*, Fourth revision, Indian Roads Congress, New Delhi, 2018.
4) IRC: 58-2015, *Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, Fourth revision, Indian Roads Congress, New Delhi, 2015.
5) MoRTH-2013, *Specifications for Road and Bridge Works*, Indian Roads Congress, New Delhi, 2013.
6) Other relevant IRC, ASTM and AASHTO standards.

vii) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to highway pavements - Types of pavements, Flexible and rigid pavements, Pavement cross-section and functions of individual layers. Functions and significance of subgrade properties, Assessment of subgrade soil strength for pavement design - Resilient Modulus; CBR and Plate load test (Recap). Soil stabilization – Mechanical stabilization, Stabilization using cement, lime, bitumen - for soils, subbase, base course mixes; Mix design. Soil – aggregate mixes, Proportioning of materials by Rothfutch's method. Alternate materials for pavements – artificial aggregates.	**9**
II	Material characterization of granular materials - Tests (Recap) and specifications for flexible and rigid pavements. Bitumen – Methods of grading, Properties; Tests (Recap). Emulsions – Properties and tests; Cutbacks – Properties and characterization; Modified binders – Types, characteristics, and uses. Aging of bitumen and aging tests.	**8**

III	Design of bituminous mixes by Marshall method; Brief study on Superpave method of mix design. Introduction to analysis of flexible pavements - Stresses, strains and deflections in homogeneous masses, Burmister's 2-layer and 3-layer theories.	**9**
IV	Wheel load stresses, ESWL of multiple wheels, Repeated loads, EWL factors and ESWL computation. Empirical, semi - empirical and theoretical approaches for flexible pavement design. Semi-empirical approach for flexible pavement design – CBR method. IRC method of flexible pavement design – Design factors, IITPave, Design as per IRC:37-2018.	**9**
V	Analysis of rigid pavements – Factors influencing stresses, Warping stresses, Frictional stresses, Combined stresses. Joints in cement concrete pavements, Joint spacings, Design and detailing of longitudinal, contraction and expansion joints. Design of slab thickness by IRC: 58-2015 method of design.	**10**
	Total hours	**45**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

ix) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41D	APPLIED HYDROLOGY	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30D HYDROLOGY AND WATER RESOURCES ENGINEERING

ii) COURSE OVERVIEW

The general objective of this course is to expose the students to the advanced concepts of hydrology and hydrologic systems. The course aims to impart the knowledge on the availability of water on hydrosphere, scientific methods quantifying the components of hydrologic cycle, statistical analysis of hydrologic datasets etc.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the different components of hydrologic cycle	Understand
CO 2	Identify the behaviour and response of the catchments	Apply
CO 3	Apply the concept of hydrograph for runoff computation	Apply
CO 4	Apply hydrological and statistical principles for estimation of flood discharge	Apply
CO 5	Identify the aquifer parameters and assess the groundwater quality	Apply

iv) SYLLABUS

Hydrology and Hydrologic cycle, Catchment characteristics, Runoff - Computation of runoff– Hydrograph analysis, Application of linear regression in hydrologic modelling, Design flood and their Estimation, Flood Routing, Flood control methods - Flood forecasting and warning, Partial differential equation governing unsteady groundwater flow, Graphical representation of hydrochemical data, Pollution of groundwater, Artificial recharge of groundwater.

v) a) TEXT BOOKS

1) Raghunath H.M., *Hydrology: Principles, Analysis and Design*, New Age International New Delhi, 3rd edition, 2015.
2) Todd D. K., *Ground Water Hydrology*, Wiley, 3rd ediion, 2011.
3) Subramanya K., *Engineering Hydrology*, Tata McGraw Hill, 4th edition, 2017.
4) Ojha, C. S. P, R. Berndtsson, P. Bhunya, *Engineering Hydrology*, Oxford University Press Learning, 9th edition, 2016.

b) REFERENCES

1) H. M. Raghunath, *Groundwater*, New Age International New Delhi,3rd edition, 2007
2) VenTe Chow, *Hand book of Applied Hydrology*, Tata McGraw Hill, 2nd edition, 2017
3) Garg S. K., *Hydrology and Water Resources Engineering*, Khanna Publishers New Delhi 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Hydrology and Hydrologic cycles, Test for consistency of rainfall data – Double Mass Curve, Analysis of rainfall data intensity, duration, frequency (IDF) curves, Depth area duration (DAD) curve. Frequency analysis-probable maximum precipitation, Hydrologic abstractions- Infiltration- Green Ampt method, Evapotranspiration-methods of estimation-Blaney Criddle method Penman method, Penmann-Montieth method.	**9**
II	Catchment Characteristics, Classification of streams – Stream pattern and stream order, Stream gauging- different methods,Selection of site for stream gauging stations. Stage Discharge Curve, Extension of stage discharge curve. Adjustment of stage discharge curve.	**9**
III	Runoff - Computation of runoff, Hydrograph analysis and S-Hydrograph, Unit hydrograph from complex storm, Synthetic unit hydrograph, Instantaneous unit hydrograph, Linear reservoir model, Application of linear regression in hydrologic model.	**9**
IV	Design flood and their Estimation - Different methods. Flood frequency studies -Gumbel's method, Flood routing-Hydrologic and Hydraulic routing, Flood routing through reservoirs – concept and approaches, Flood routing through channels - Muskingum method. Flood control methods, Flood forecasting and warning.	**9**
V	Partial differential equation governing unsteady groundwater flow, Evaluation of aquifer parameters-Theis method, Jacob's approximation method, Well flow near aquifer boundaries - Method of images, Surface investigation of groundwater - Electrical resistivity method. Graphical representation of hydrochemical data, Pollution of groundwater- sources; Seawater intrusion- Ghyben-Herzberg relationship, Method of control of seawater intrusion; Artificial recharge of groundwater flow.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41E	CONSTRUCTION PLANNING AND MANAGEMENT	PEC	3	0	0	3	2020

i) PRE-REQUISTE: NIL

ii) COURSE OBJECTIVES:

The goal of this course is to provide knowledge in planning and management of construction projects. The course also deals with various operations encountered in a construction project in different phases throughout the lifecycle of a project, from planning, design, construction and operations. The course also helps students to develop the required skills to plan and manage various types of construction projects effectively and efficiently using the latest technologies like BIM.

iii) COURSE OUTCOMES:

After the completion of the course the student will be able to:

CO1	Apply knowledge of Planning and Management for planning and execution of Construction Projects	Apply
CO2	Explain techniques for Project Planning, Scheduling, Construction Administration and Management	Understand
CO3	Explain the criteria for selecting the appropriate method and tools as per the requirement of each project or site.	Understand
CO4	Explain the latest industry standards and technologies used in construction projects for planning and management.	Understand
CO5	Explain the financial and legal aspects involved in a construction project.	Understand

iv) SYLLABUS

Objectives of construction planning and management, Importance of Management in Construction, Challenges in construction, Construction team, Organisation and Hierarchy in Construction Projects, Construction scheduling, Introduction to BIM Technology, BIM Benefits, Construction Management and Planning using BIM, Human Resource Management, Materials Management, Quality control in Construction, Construction Safety Management, Economic analysis of projects, Tendering, Contract, Accounting, Budgetary Control Systems, Financial Management, Working Capital Management.

v) REFERENCES:

1) Singh, K. and Kansasl, M. L., *Project Planning and Management with CPM and PERT*, HP Hamilton Limited, 2021.

2) Brad Hardin, Dave McCool, *BIM and Construction Management: Proven Tools, Methods, and Workflows* Paperback – 2017 .

3) Lester, A., *Project Management, Planning and Control*, Butterworth-Heinemann, 7th edition, 2017.

4) Srinath, L.S. *PERT and CPM Principles and Applications*, 3rd ed. Affiliated East-West Press, New Delhi 2015.

5) Kumar Neeraj Jha, *Construction Project Management*, 2nd ed Pearson, Dorling Kindersley (India) pvt. Ltd 2015

6) K. K. Chitkara, *Construction Project Management Planning Scheduling & Controlling*, Tata McGraw Hill, New Delhi 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Objectives of construction planning and management. Importance of Management in Construction, Challenges in construction, Construction team- Roles, responsibilities and skills. Organisation and Hierarchy in Construction Projects – Types, Characteristics, Functions and Flow charts. Construction scheduling: Review of CPM and PERT (AoN network), Time-cost trade-off – Cost optimization through the crashing of a network, Resource smoothing and resources levelling – concept only.	9
II	Introduction to BIM Technology: Define BIM and BIM model, Describe workflow in using BIM in the building lifecycle, Model-Based cost estimating, Perform Simulations, Apply BIM to reduce error and change orders in projects, Evaluate and communicate ideas related to the use of BIM in the building life cycle. BIM Benefits: Case Studies, Organizational Maturity and Dimensions, Construction Management and Planning using BIM Labour Legislations pertaining to the construction industry, Payment of Wages Act, Minimum Wages Act, Contract Labour Act, Labour Welfare Fund Act, Workmen's Compensation Act.	9
III	Human Resource Management: manpower estimation at various stages, recruitment, training, under and overmanning. Materials Management: Materials of construction, classification codification, ABC analysis, estimation of materials procurement, inventory/stock control, Economic Order Quantity, purchase procedure, stores management.	9

	Quality control in Construction: Importance of quality, elements of quality, organization for quality control, quality assurance technique. Construction Safety Management: Important causes of accidents on construction sites, safety measures, safety management in major construction works such as earthwork and excavation, drilling and blasting, tunneling, piling, dewatering and concreting, safety benefits to employees, employees and customers.	
IV	Economics of Project Management: Economic analysis of projects – NPV, Rate of return analysis, cost-benefit analysis. Tendering – E Tendering / Electronic Process. Contract – Contractual relation and contract management, Contract documents and conditions of Contract, Contract agreement Technical terms only - Administrative approval, Technical Sanction, Secured Advance, Mobilization Advance, Heads of accounts in government organization, Earnest money deposit (EMD) and Security deposit (SD). Accounting- Terms only- Work Abstract, Cash book, Work register, Accounting for the materials, Measurement book, Muster roll and Record of Bills	**9**
V	Budgetary Control Systems: Types of budgets, new approaches for budgeting, responsibility of accounting, profit centre approach. Financial Management: Meaning and scope, financial statement analysis, financial ratio analysis, funds flow analysis. Working Capital Management: Meaning, policy for working capital, estimating working capital needs. Capital investment decision, long term financing working of financial institutions in India and abroad, self-financing, financing mechanisms.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41F	ADVANCED ENVIRONMENTAL ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30G ENVIRONMENTAL ENGINEERING

ii) COURSE OVERVIEW

This course introduces students to the state of technologies that exist for treating water and air. They will learn basic engineering principles that govern these technologies and develop the capacity to select appropriate technologies for solving environmental problems related to water and air pollution.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain various secondary treatment technologies for wastewater	Understand
CO 2	Explain various tertiary treatment technologies for wastewater and their applications	Understand
CO 3	Apply engineering principles to design various secondary and tertiary treatment units for wastewater	Apply
CO 4	Identify appropriate technology for controlling air pollution	Apply

iv) SYLLABUS

Advances in wastewater, Aerobic attached growth Process, Advanced Oxidation Processes, Adsorption, Applications in water treatment, Membrane Technology, Membrane Bio-Reactors MBR), MBR configurations, Air Pollution Control.

v) a) TEXT BOOKS

1) Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., *Environmental Engineering*, Mc Graw Hill Education, 2017.
2) Davis, M.L., Cornwell, D.A., *Introduction to Environmental Engineering*, Mc Graw Hill Education, 2017.
3) Garg, S.K., *Sewage disposal and air pollution engineering*, Khanna Publishers, 2021.

b) REFERENCES

1) Metcalf and Eddy, *Wastewater Engineering: Treatment and Reuse*, Tata McGraw Hill publishing Co. Ltd., 2017.
2) Qasim, S.R., *Wastewater Treatment Plants-Planning, Design & Operation*, CRC Press, 2017.

3) Baker, *Membrane Technology and Applications*, 3rd ed., Wiley-Blackwell, 2012.
4) Fane, Schaefer, Waite, Nanoflitration*, Principles and applications*, Elsevier, 2004

vi) COURSE PLAN

Module	**Contents**	**No. of hours**
I	Process for biological nitrogen removal –Process for biological phosphorus removal - anoxic-aerobic process design – sequencing batch reactor (SBR)	**9**
II	Aerobic attached growth Process – Rotating Biological Contactor (RBC), Moving Bed Biofilm Reactor (MBBR) Advanced Oxidation Processes-Fenton process, Wet Air Oxidation process, Photo-Oxidation process	**9**
III	Adsorption- Removal of organic and inorganic contaminants- Popular adsorbents-Adsorption Isotherms-Breakthrough Curves in Continuous Adsorption Processes- Adsorption in a Batch Contactor-Adsorption kinetics-Regeneration of spent adsorbents Ion Exchange-method of purification-Applications in water treatment	**9**
IV	Membrane Technology- Reverse Osmosis (RO)- Ultra Filtration(UF)-Nano Filtration(NF)- Micro Filtration(MF)- Electro Dialysis (ED)-Dimensioning of RO units for desalination. Tertiary filtration of waste water- design of Membrane Bio Reactors (MBR), MBR configurations	**9**
V	Air Pollution Control- Control devices for Particulate pollutants – Cyclone separators, baghouse filters, wet scrubbers, electrostatic precipitators (ESP)- Design of an ESP Gaseous pollutant control-technologies for the control of sulfur oxides, nitrogen oxides and carbon monoxide- wet scrubbing, process modification	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41G	OPTIMIZATION TECHNIQUES IN CIVIL ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

The general objective of this course is to expose the students to the fundamental concepts of optimization problem formulation in various fields of Civil Engineering. After this course, the students will be able to identify the type of the real-world optimization problems and design solutions using the corresponding optimization techniques.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Make use of the different optimization techniques to formulate an engineering design problem as an optimization problem.	Apply
CO2	Utilize suitable optimization techniques to develop optimized solutions to various Civil Engineering problems.	Apply
CO3	Analyze the problem as a linear or nonlinear optimization problem using the suitable optimization technique.	Analyze
CO4	Analyze the problem as a single variable or multi-variable optimization problem using the corresponding optimization technique.	Analyze
CO5	Solve transportation and assignment problems and develop genetic algorithms.	Apply

iv) SYLLABUS

Introduction to optimization methods, Classification of optimization problems, Single Variable Unconstrained Optimisation Techniques - Bracketing methods, Multivariable Unconstrained Optimisation Techniques, Linear programming, main duality theorem, complementary slackness theorem, introduction to sensitivity analysis, examples of applications of linear programming in engineering, Transportation problem, Introduction to Genetic Algorithms

v) (a) TEXT BOOKS

1) Rajasekharan S., *Numerical Methods in Science and Engineering,* 1st edition, S Chand & company, 2003.
2) Ravindran, Phillips, D. T. and Solberg, J. J.,Operations *Research – Principles and Practice,* 2nd edition, John Wiley and Sons, 2007.
3) Rao, S. S., *Engineering Optimisation – Theory and Practice*, 4th edition, John Wiley & Sons, Inc., 2009.

4) Arora, J. S., *Introduction to Optimum Design*, 4th edition, McGraw Hill, 2016.

(b) OTHER REFERENCES

1) Grewal, B. S., *Numerical Methods in Engineering and Science,* 11th edition, Khanna Publishers, 2017.
2) Taha, H. A., Operations Research- An introduction, 10th edition, Pearson education, 2019.
3) Ravindran, Ragsdell, K. M. and Reklaitis, G. V., *Engineering Optimization – Methods and Applications*, 1st edition, John Wiley and Sons, 2006.
4) Bazaraa, M. S., Sherali, H. D. and Shetty, C. M., *Nonlinear Programming: Theory and Algorithms,* 3rd edition, Wiley-Interscience, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to optimization methods- optimization problem formulation - objective function, constraints. Classification of optimization problems. Geometric, graphical, analytical methods of optimization. Application examples from engineering.	8
II	Single Variable Unconstrained Optimisation Techniques- Optimality Criteria. Bracketing methods: Unrestricted search, Exhaustive search. Region Elimination methods: Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method. Interpolation methods: Quadratic Interpolation method, Cubic Interpolation method. Gradient Based methods: Newton-Raphson method, Secant method, Bisection method.	10
III	Multivariable Unconstrained Optimisation Techniques- Optimality Criteria- Unidirectional Search. Direct Search methods: Random search, Grid search, Univariate method, Hooke's and Jeeves' pattern search method, Powell's conjugate direction method, Simplex method. Gradient based methods: Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher Reeves) method, Newton's method, Variable metric (DFP)method, BFGS method.	10
IV	Linear programming, simplex method- dual problem, weak duality theorem, optimality criterion theorem, main duality theorem, complementary slackness theorem, primal-dual relationship, economic interpretation of dual solution, introduction to sensitivity analysis examples of applications of linear programming in engineering.	9

V	Transportation problem- Assignment problem- applications of linear programming problems in Civil Engineering- Introduction to Genetic Algorithms- basic concept- problem formulation - operations- convergence criteria.	**8**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41H	MUNICIPAL SOLID WASTE MANAGEMENT	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to create an awareness of different types of solid waste generated in our environment and their ill effects. The course also gives the details of various municipal solid waste management methods like generation of solid waste, storage, collection, processing and disposal technologies.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the classification and characteristics of solid wastes based on their source.	Understand
CO 2	Identify the composition and methods of quantifying municipal solid wastes.	Apply
CO 3	Explain various collection services and processing techniques of municipal solid wastes.	Understand
CO 4	Explain the disposal of municipal solid wastes by sanitary landfill and incineration technologies.	Understand
CO 5	Explain composting and anaerobic digestion of municipal solid wastes.	Understand

iv) SYLLABUS

Solid wastes- Categories, Sources, Characteristics. Solid waste management rules. Generation of solid wastes, Collection of solid Wastes, Processing techniques, Disposal technologies-Physical, Thermal, Biological methods. Energy from solid wastes.

v) a) TEXT BOOKS

1) Sincero, A.P. and Sincero, G. A., *Environmental Engineering: A Design Approach*, Prentice Hall Publisher, 1996
2) Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw Hill Education, 2017.
3) Worrell, W. A., Vesilind, P. A. and Ludwig, C., *Solid Waste Engineering: A Global Perspective*, Cengage learning, 2016.

4) Tchobanoglous, G. and Kreith, F., *Handbook of Solid Waste Management*, McGraw hill publications, Newyork, 2002.

b) REFERENCES

1) Pichtel, J., *Waste Management Practices*, Taylor and Francis publishers, 2014.
2) Cornwell, D. A. and Davis, M. L., *Introduction to Environmental Engineering*, McGraw Hill International Edition, 2012.
3) Botkin, D. B. and Keller, E. A., *Environmental Science (Earth as a living plant)*, John Wiley and Sons Inc, 4th edition, 2005
4) Corbitt, R. A., *Handbook of Environmental Engineering*, McGraw Hill Publishing Company, 1999.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Wastes-Terms and definitions- Sources, Characteristics and Management: Categories of wastes- Municipal, Industrial, Medical, Universal, Construction and demolition debris, Radioactive, Mining, E wastes, Agricultural waste. Solid waste management rules.	**9**
II	Municipal solid waste generation- Methods of estimation of generation rate- Measure of quantities, Sampling procedure, Composition- Physical and chemical (simple problems). Storage of solid waste.	**9**
III	Collection – Collection services- Collection systems, Collection routes- Need for transfer operation. Resource conservation and recovery. Processing techniques- Mechanical volume and size reduction, Chemical volume reduction, Component separation, Drying (simple problems).	**9**
IV	Disposal of solid waste: Sanitary landfill- Area method, Trench method- Advantages and disadvantages, Incineration- Types of incinerators – Parts of an incinerator-Incinerator effluent gas composition.	**9**
V	Composting- Types of composting- Indore process, Bangalore process- Advantages and disadvantages. Anaerobic digestion of wastes, Biogas digesters. Case study on municipal solid waste management.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U41J	APPLIED SOIL MECHANICS	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U20E Geotechnical Engineering –I , CE1U30C Geotechnical Engineering –II

ii) COURSE OVERVIEW:

The objective of this course is to introduce the subject of applied soil mechanics and advanced geotechnical engineering to all civil engineering students.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Demonstrate the application of plane stress and plane strain in a given situation.	Understand
CO 2	Explain the minerals and bonds of clayey soil and factors governing its engineering behaviour.	Understand
CO 3	Make use of constitutive relationships for soils and its application in solving various engineering problems.	Apply
CO 4	Discuss the behaviour of soil considering various failure criteria and stress and strain paths.	Apply
CO 5	Discuss critical straight line, state boundary surfaces and elastic & plastic deformation of soil.	Apply

iv) SYLLABUS

Introduction to genesis of soils, basic clay mineralogy; Stresses and Strains; failure criteria, soil laboratory tests; Critical state and stress paths. Shear Strength and Stiffness of Sands.

v) (a) TEXT BOOKS

1) Holtz, R. D. & Kovacs, W. D., *An Introduction to Geotechnical Engineering*, Prentice Hall India, 2nd edition, 2011.
2) Mitchel, J. K., *Fundamentals of Soil behaviour*, John Wiley & Sons, 3rd edition, 2005.
3) Lambe, T. W. and Whitmen, R. V., *Soil Mechanics*, Wiley Eastern Ltd., 2000.

(b) REFERENCES

1) Wood, D. M., *Soil Behaviour and Critical State Soil Mechanics*, Cambridge University Press, 1991.
2) Salgado, R., *The Engineering of Foundations*, McGraw Hill, 1st 2006.
3) Terzaghi, K., *Theoretical Soil Mechanics*, John Wiley & Sons, 1967

vi) COURSE PLAN

Module	Contents	No. of hours
I	Elements of elasticity - State of stress at a point, stress function, equilibrium equation, compatibility equation, boundary conditions, Hooke's law. Elements of plasticity - Ideal plastic substance, strain hardening, yield criteria,Camclay Model.	9
II	Clay Minerals-Classification, Structure, properties; Identification of clay minerals - X ray Diffraction, Electron Microscope and Differential Thermal Analysis.	9
III	Shear strength of clays - Stress-strain behaviour - Triaxial testing and stress path plotting - pore pressure parameter of Skempton and Henkel - Total stress and effective stress approach - shear strength of partially saturated clay in terms of stress state variables, Factors influencing stress strain shear strength.	9
IV	Concepts of yield and failure in soils- yield criteria of von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr-Coulomb failure criterion.	9
V	Introduction to critical state soil mechanics - state boundary - surface- Roscoe and Hvorslev's surface - A perspective on mechanical behaviour of soils within the critical state framework.	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

OPEN ELECTIVE

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0U41A	INTRODUCTION TO ENVIRONMENTAL IMPACT ASSESSMENT	OEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to introduce the methodologies for identifying, predicting, evaluating and mitigating the impacts on the environment due to any developmental project or activities. The course also creates awareness on the environmental clearance procedures in India and preparation of an impact assessment report.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the need for conducting environmental impact assessment and environmental audit	Understand
CO 2	Outline the environmental legislations and EIA clearance procedure in India	Understand
CO 3	Apply various methodologies for assessing the environmental impacts of any developmental activity	Apply
CO 4	Identify the various impacts through different case studies on EIA	Apply

iv) SYLLABUS

Definition, Need for EIA, Evolution of EIA-Environmental legislations in India-Environmental clearance process in India-Types of EIA-EIA methodologies-Environmental Management Plan (EMP)- Environment Audit- ISO 14001 standards- EIA case studies

v) (a) TEXT BOOKS

1) Canter, L. W., *Environmental Impact Assessment*, McGraw Hill Inc., NewDelhi,1996.
2) Anjaneyulu, Y., *Environmental Impact Assessment Methodologies*, B. S. Publications, Hyderabad, 2020.
3) Barthwal, R. R., *Environmental Impact Assessment,* New Age International Publishers, 2012.

4) Shukla, S. K. and Srivastava, P. R., Concepts *in Environmental Impact Analysis*, Commonwealth Publishers, New Delhi, 2017.

(b) REFERENCES

1) Glasson, J. and Therivel, R., *Introduction to Environmental Impact Assessment*, Routledge Publications, Fifth Edition, 2019.
2) Reddy, M. A., *Environmental Impact Assessment* -Theory and Practice, BS Publications, 2017.
3) Lawrence, D. P., *Environmental Impact Assessment (Practical Solutions to Recurrent Problems)*, Wiley International, New Jersey, 2005.
4) Ministry of Environment and Forests, EIA *Notification*, Govt. of India, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition, Need for EIA, Evolution of EIA: Global & Indian scenario - Environmental legislations in India- The Water (Prevention & Control of Pollution) Act 1974, The Air (Prevention & Control of Pollution) Act 1981, The Environmental (Protection) Act 1986- Environmental standards for water, air and noise quality- EIA Notification 2006	9
II	Environmental clearance process in India: Screening, Scoping, Public Consultation, Appraisal- Form1-Category of projects- Generic structure of EIA report- Terms of Reference (ToR) -Types of EIA: strategic, regional, sectoral, project level- Rapid EIA and Comprehensive EIA- Initial Environmental Examination (IEE)	9
III	EIA methodologies: Ad hoc, checklist, matrix, network and overlay- Impact Prediction, Evaluation and Mitigation- Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment- assessment of ecological impacts and Socio economic Impacts.	9
IV	Environmental Management Plan (EMP): Goal and purpose- Importance of EMP- Content of an EMP- Role of environmental monitoring program Environment Audit: need for audit- audit types and benefits- environmental audit procedure. ISO 14001 standards: Importance, salient features - Stages in implementation- Benefits	9
V	EIA case studies (Indian)- a highway project, a hydroelectric power plant, an airport project, a quarry mining project and a solid waste management project.	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43D	INFRASTRUCTURE MANAGEMENT WITH INFORMATICS	OEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The goal of this course is to introduce students to the scope of Informatics and Internet of Things (IoT) in Civil Engineering. It covers the fundamental applications of data analytics, informatics and IoT.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of data science, informatics and internet of things.	Understand
CO 2	Identify the use of geomatics in planning and site selection of infrastructure projects	Apply
CO 3	Apply building informatics in construction, monitoring and project management.	Apply
CO 4	Utilize IoT technology in infrastructure management.	Apply

iv) SYLLABUS

History of informatics, analysis techniques, Concepts in Geo-informatics, Application of geo-informatic systems, Building Information Modelling, applications of BIM, IoT Standards and Protocols, Concept and Applications of IoT.

v) (a) TEXT BOOKS

1) J. Campbell, *Essentials of Geographic Information Systems*, Saylor Foundation,2nd edition 2017.
2) Ramez Elmasri, Shamkant B.Navathe, *Fundamental of Database Systems*, Pearson Addison Wesley,7th edition 2017.
3) BIM Handbook: *A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*, Publisher: John Wiley & Sons; 2nd edition, 2011.

(b) REFERENCE BOOKS

1) Raja R. A. Issa and Svetlana Olbina, *Building Information Modeling: Applications and Practices*, ASCE, 2015.

2) Samuel Greengard, *The internet of things*, The MIT Press Essential Knowledge Series, 2015, ISBN: 978-0-262-52773-6.

3) Shashi Shekhar and Sanjay Chawla, *Spatial Databases: A Tour*, Prentice Hall, 2003.

vi) COURSE PLAN

Module	**Contents**	**No. of hours**
I	History of informatics, DIKW pyramid & Meta data, Data management, Data types & Metadata, Database management systems, Data analysis techniques, Trends & Patterns in data analysis.	**9**
II	Fundamental concepts in Geo-informatics- Components of GIS, Spatial data and attributes, Data models- vector & raster, Vector data analysis, Raster data analysis- local & neighbourhood analysis, Raster data analysis- zonal analysis.	**9**
III	Site suitability analysis for Residential area, Site suitability analysis for Industrial area, Site suitability analysis for reservoir, Ground water potential zonation & Hazard zonation mapping, Network analysis for water supply, Network analysis for power line, Network analysis for road network.	**9**
IV	Building Information Modelling- Definition, Elements of BIM, Steps in BIM development, COBie standard, Potential & applications of BIM.	**9**
V	IoT Standards & Protocols, Concept of IoT in civil engineering, Application of IoT in construction, product monitoring & project management, Management applications of IoT- Traffic, water supply, smart buildings	**9**
	Total hours	**45**

v) MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

vi) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0U41B	APPLIED EARTH SYSTEMS	OEC	3	0	0	3	2020

I) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The goal of this course is to introduce students to the concepts of the earth system and its interrelated components, their processes and mechanisms.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the concept of earth as a system of interrelated components and associated exogenic/endogenic processes.	Understand
CO 2	Outline the process of weathering, transportation and deposition and its influence on earth systems.	Understand
CO 3	Explain the significance and conservation methods of soil and its control measures.	Understand
CO 4	Make use of the Plate tectonics theory to explain the geodynamic features and processes of earth's surface.	Apply
CO 5	Explain the concepts of marine environment and their influence on other subsystems.	Understand
CO 6	Summarize the implications of human interaction with the Earth system.	Understand

iv) SYLLABUS

Basic concept of Earth as a system and its component sub systems. Weathering-influence on earth systems, Types and controlling factors, Fluvial processes, Stages of stream development; Drainage patterns. Soil- formation and conservation methods. Deserts-distribution and controls. Wagner's ideas of continental drift, Plate Tectonics-mechanisms of plate movements. Brief account of marine sediments, basic outlines of origin and circulation, coral reefs- types and concepts, Basics of atmosphere and processes: Structure and composition of the atmosphere, Green House Effect and Global warming- basic ideas about their causes and effects.

v) a) TEXT BOOKS

1) Fetter C., Applied Hydrogeology, CBS Publishers, New Delhi, 2007.
2) Carlson, DH, Plummer, CC and McGreary, D Physical geology: Earth Revealed Mc GrawHill New York, 2006.

b) REFERENCES

1) Pinet P. R., *Oceanography – An Introduction to the Planet Oceanus*, West Publishing Co,1992
2) Soman K., *Geology of Kerala*, Geological Society of India, Bangalore, 2001

vi) COURSE PLAN

Module	Contents	No. of hours
I	Basic concept of Earth as a system, interactions between its component sub systems. Fundamental concepts of equilibrium Geomorphic agents and processes.	**9**
II	Weathering- relevance, influence of and on earth systems Types and controlling factors. River as a system, Fluvial processes-hydrological cycle, fluvial erosion, transportation, deposition and landforms. Stages of stream development -Drainage patterns and implications.	**9**
III	Soil- significance and controls, soil profile-Soil erosion and conservation methods -Deserts-distribution and controls.	**9**
IV	Wagner's ideas of continental drift, limitations-Plate Tectonics-background of the theory, evidences- Plate boundaries and their features, seismicity and volcanism vis-à-vis plates- Mechanisms of plate movements.	**9**
V	Importance of marine environment- Circulation in oceans- surface circulation in deep sea (Atlantic and Pacific Oceans), coastal upwelling and downwelling- Outlines of ocean floor topography, brief account of marine sediments Turbidity currents- Coral reefs- types and concepts about their formation- Structure and composition of the atmosphere-Heat budget, radiation balance of earth, GreenHouse Effect and Global warming, basic ideas about their causes and effects.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0U41D	NATURAL DISASTERS AND MITIGATION	OEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The objective of the course is to introduce the concept of disasters, their causes and their mitigation and management.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of hazards and disasters and terminology related to disaster management.	Understand
CO 2	Explain the classification, causes and impacts of different types of natural disasters	Understand
CO 3	Identify the activities involved in various phases of disaster management cycle	Apply
CO 4	Identify the management plans for various natural disasters and the role of technology involved in disaster mitigation	Apply

iv) SYLLABUS

Hazards and disasters: Introduction to key concepts and terminology, Extent and nature of natural hazards: types, causes, impacts and mitigation methods, Disaster Management cycle- pre-disaster phase, actual disaster phase, post- disaster phase. Hazard and disaster management plans for various natural disasters, Technology in disaster management.

v) (a) TEXT BOOKS

1) Valdiya, K.S., *Environmental Geology - Ecology, Resource and Hazard Management*, McGraw-Hill Education (India) Private Limited., 2013
2) Jha, M.K. (Ed.), *Natural and Anthropogenic Disasters- Vulnerability, Preparedness and Mitigation*, Springer, Amsterdam, 2016
3) Ariyabandu, M. and Sahni P., *Disaster Risk Reduction in South Asia*, Prentice-Hall (India), 2016.
4) Shaw, R and Krishnamurthy, RR (Ed.) , *Disaster Management: Global Problems and Local Solutions*, Universities Press (India) Ltd.,2009

(b) REFERENCES

1) NDMA*, National Policy on Disaster Management*, Ministry of Home Affairs, Government of India,2009.

2) NDMA, *Disaster Management in India - A Status Report*, Ministry of Home Affairs, Government of India, New Delhi,2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Hazard, disaster, their characteristics and effects, interaction between subsystems of earth that bring about hazards and their intensification. Classification, how development is connected to disasters. Disaster cycle. Hazard and disaster Terminology: vulnerability and types, exposure, risk, capacity, crisis, emergencies, resilience etc. basic concepts of carbon footprint	**9**
II	Natural Disasters: General classification, Causes, types, impact of: Earth quakes, volcanoes, floods, storm surges, tsunamis Assessment and mitigation of: Floods, types Coastal disasters: Earth quakes, volcanoes, floods, flash floods, storm surges, tsunamis.	**9**
III	Soil, formation, significance and characteristics. Soil degradation, engineering and agricultural methods of prevention Desertification: nature and mechanisms, mitigation Landslides: processes, controlling factors, classification and impact and alleviation Forest fires: incidence and means and deterrence	**9**
IV	Steps in Risk Management and Assessment, Disaster management Cycle-Prevention, Preparedness, Response, and Recovery SWOT Analysis- concepts, uses, limitations and advantages Disaster management plan and reports, participation of community in disaster management	**9**
V	Hazard and Disaster Management: relief camps, organisation and amenities. Behavioral aspects of management- psychological considerations, training in human professionalism, individual and community empowerment Management of floods, storm surges, landslides, earthquakes, forest fires: pre-disaster phase, actual disaster phase, post-disaster phase. Relief and Amenities, Relief camps, organization, camp layout, food requirement, water needs, sanitation, security. Concepts of EIA and sustainable development technology in disaster management	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0U41E	ENVIRONMENTAL HEALTH AND SAFETY	OEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The course is designed to build environmental health literacy among students and encourages them to take safety measures against various environmental hazards. It motivates the students in maintaining and improving the quality of the environment and empower learners to take appropriate actions to reduce the environment pollution

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the toxicology and occupational health hazards associated with industries	Understand
CO 2	Identify the various chemical and biological hazards that can impact human health.	Apply
CO 3	Identify various measures to ensure safety in construction industry.	Apply
CO 4	Explain the effects of various pollutants on environment and human health	Understand
CO 5	Identify various measures for providing a safe working environment in different types of industries.	Apply

iv) SYLLABUS:

Introduction to Occupational health and Toxicology, Industrial Hygiene, Chemical hazards, Biological hazards, Safety in construction industry, Air pollution, Water Pollution, Waste Management, Safe working environment: Safety inspection. conservation of natural resources.

v) (a) TEXT BOOKS

1) Jain, R.K., and Rao, S. S., *Industrial Safety, Health and Environment Management Systems*, Khanna Publishers, New Delhi ,2006.

2) Taylor, B., *Effective Environmental, Health and Safety Management Using the Team Approach*, Culinary and Hospitality Industry Publications Services, 2005.

3) Gallant, B., *The Facility Managers Guide to Environmental Health and Safety* Government Inst. Publ., 2007.

(b) REFERENCES

1) Davis, M.L., *Introduction to Environmental Engineering*, Mcgraw Hill Education, (India), 2012
2) Course Manual, *Associate Fellow of Industrial Health (AFIH)*, Government of India, 2019.
3) Slote. L, *Handbook of Occupational Safety and Health*, John Willey and Sons, NewYork, 1987.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Occupational Health and Toxicology. Safety at work – Socio – Economic reasons. Introduction to health and safety at various industries. Occupational related diseases- Musculoskeletal disorders, hearing impairment. Occupational related diseases-carcinogens, silicosis, asbestosis, pneumoconiosis. Toxic materials and substances used in work. Exposure limits, toxicological investigation. Industrial Hygiene. Arrangements by organisations to protect the workers.	9
II	Chemical hazards. Dust, fumes, vapour, fog, gases, Methods of Control. Biological hazards. Classification of Biohazardous agents. Bacterial agents, viral agents, fungal, parasitic agents, infectious diseases. Control of biological agents at workplaces Noise, Noise exposure regulation and control.	9
III	Safety in Construction industry- Scaffolding and Working platform. Welding and Cutting, Excavation Work, Concreting. Control measures to reduce the risk. Electrical Hazards. Protection against voltage fluctuations. Effects of shock on human body, Radiation Hazards, Types and effects of radiation on human body, Disposal of radioactive waste.	9
IV	Air Pollution - air pollutants from industries. Effect on human health, animals. Plants and Materials - depletion of ozone layer. Concept of clean coal combustion technology. Water Pollution - water pollutants. Health hazards - effluent quality standards. Waste Management-waste identification. Characterization and classification. Recycling and reuse.	9
V	Safe working environment in different types of industries- purpose and benefits of safety inspection. First-aid appliances. Shelters, rest	9

	rooms and lunch rooms. Use of personal protective equipment. Role of an individual in conservation of natural resources.	
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0U41F	GEOINFORMATICS	OEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

Goal of this course is to expose students to the basics of geographical information system. It introduces students to the basic concepts in geospatial data handling and analysis. Various steps involved in developing a geographical information system and the use of GIS for different applications is also dealt with.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain basic concepts of GIS and spatial data.	Understand
CO 2	Explain various datatypes and database management.	Understand
CO 3	Choose various spatial data collection technologies and analysis techniques.	Apply
CO 4	Make use of GIS in various applications.	Apply

iv) SYLLABUS

Introduction to GIS, History and development of GIS, Coordinate reference systems, components of GIS, data sources in GIS, data input methods, Type of data, Spatial and attribute data, Data models- vector and raster, Spatial data structure, Spatial data analysis; GIS Modelling, Global navigation satellite systems, Global positioning system - components and principle, Application of GIS in various fields site suitability analysis.

A mini project on application of GIS.

v) a) TEXT BOOKS

1) Anji Reddy, M. *Remote Sensing and Geographical Information System*, BSP Publications., 2012.
2) Chang, K., *Introduction to Geographic Information Systems*, Tata McGraw Hills Edition, New Delhi, 2007.
3) Campbell, J. B. and Shin, M., *Geographic Information System Basics*, PHI of India, New Delhi, 2012.

b) REFERENCES

1) Burrough P.A., McDonnell, R. A., Lyod, A., *Principles of GIS for Land Resources Assessment*, Oxford Publication, 2015.

2) Clarke, K. C. Parks B. O., and Crane M.P., *Geographic Information systems and Environmental Modelling*, PHI of India, New Delhi, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to GIS, History and development of GIS, Spatial data concepts, Coordinate reference systems, datum and projections, map scales, georeferencing, components of GIS, data sources in GIS, data input methods, file formats for GIS, standard GIS packages	**9**
II	Type of data, Spatial and attribute data, Data models- vector and raster, Spatial data structure-Vector data structure and raster data structure, Database management systems (DBMS), Relational database management systems (RDBMS)	**9**
III	Spatial data analysis, single layer operations- spatial and attribute query, buffer analysis, point pattern analysis, network analysis, surface analysis, interpolation; multi-layer operations-topological overlays, point in polygon, line in polygon, polygon in polygon, logical operators-AND, OR, NOT, XOR, vector overlay operations-Clip, erase, split, union, identity and intersect; raster calculators; GIS Modelling	**9**
IV	Digital elevation model (DEM), digital terrain model (DTM), triangular irregular network (TIN), Global navigation satellite systems- types, Global positioning system- components and principle, satellite ranging- calculating position, GPS errors and biases, Differential GPS (DGPS)	**9**
V	Application of GIS in various fields- Urban planning, agriculture, disaster management, forest management, site suitability analysis for infra projects, environmental science, sales and marketing. A mini project on application of GIS.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U40A	INDUSTRIAL SAFETY ENGINEERING	MNC	2	1	0	-	2020

i) **PRE-REQUISITE:** NIL

ii) **COURSE OVERVIEW:**

Objective of the course to impart knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context.

iii) **COURSE OUTCOMES:**

After the completion of the course, the student will be able to:

CO No	Course Outcomes	Level
CO1	Explain the theories of accident causation and preventive measures of industrial accidents.	Understand
CO2	Explain about personal protective equipments, its selection, safety performance, role of housekeeping and work permits in industry.	Understand
CO3	Explain different safety issues in construction industries.	Understand
CO4	Summarize various hazards associated with different machines and material handling.	Understand
CO5	Explain different hazard identification tools in industries with the knowledge of different types of chemical hazards.	Understand

iv) **SYLLABUS:**

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management,

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning &

Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders**.**

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. Hearing Conservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, Material Safety Data Sheets

a) TEXTBOOKS

1) R.K Jain (2000) Industrial Safety, *Health and Environment management systems*, Khanna Publications.

2) Paul S V (2000), *Safety management System and Documentation training* Programme handbook, CBS Publication.

3) Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.

b) REFERENCES

1) AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Procedures*. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

2) Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.

vi)

COURSE PLAN:

Module	Contents	No. of hours
I	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety, organization- objectives, types, functions, Role of management, supervisors, workers, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.	**9**

II	Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces. Technology generation and development, technology generation, process, technology development, importance of technology generation and development.	**9**
III	Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	**9**
IV	Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	**9**
V	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U48A	ENVIRONMENTAL ENGINEERING LAB	PCC	0	0	3	2	2020

i) PRE-REQUISITE: CE1U30G ENVIRONMENTAL ENGINEERING

ii) COURSE OVERVIEW

This lab equips the students to analyze the various physicochemical and bacteriological characteristics of water and recommend its suitability as drinking water based on water quality standards.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply standard methods to determine various physicochemical and bacteriological characteristics of water	Apply
CO 2	Compare the quality of water with drinking water standards and recommend its suitability for drinking purposes	Apply

iv) SYLLABUS

Physical characteristics - Electrical Conductivity, Turbidity

Chemical characteristics - pH, Solids, Alkalinity, Acidity, Hardness, Chlorides, Available chlorine, Breakpoint chlorination, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Optimum coagulant Dosage, Sulphates, Fluoride, Nitrates, Phosphates, Iron, Heavy Metals (any two)

Biological Characteristics - Total Coliforms

v) REFERENCES

1) APHA, *Standard Methods for the Examination of Water and Wastewater*, 23rd edition, American Public Health Association, American Water Works Association, Water Environment Federation, 2017.
2) Garg, S. K., *Water Supply Engineering*, 33rd edition, Khanna publishers.
3) Garg, S. K., *Sewage Disposal and Air Pollution Engineering*, 39th edition, Khanna publishers
4) IS 10500 : 2012, *Drinking Water - Specification*, Bureau of Indian Standards, New Delhi, 2012.

vi) COURSE PLAN

Experiment No.	List of experiments	No. of hours
I	Determination of pH, Electrical Conductivity and Turbidity	3
II	Determination of TS, TDS, TSS, TVS	3
III	Determination of Alkalinity and Acidity	3
IV	Determination of Hardness	3
V	Determination of Chlorides	3
VI	Determination of Available Chlorine/Breakpoint Chlorination	3
VII	Determination of Dissolved Oxygen, Biochemical Oxygen Demand	3
VIII	Determination of Chemical Oxygen Demand	3
IX	Determination of Optimum Coagulant Dosage	3
X	Determination of Sulphates	3
XI	Determination of Fluorides	3
XII	Determination of Nitrates/ Phosphates	3
XIII	Determination of Total Iron	3
XIV	Determination of Heavy Metals (any two)	3
XV	Determination of Total Coliforms	3
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test : 30 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U49A	SEMINAR	PWS	0	0	3	2	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

This course is intended to enable a student to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Collect and compile information about any contemporary issues in the field of Civil engineering or allied fields.	Analyse
CO 2	Analyze the information and draw inferences regarding the issues studied.	Analyse
CO 3	Take part in lifelong learning and understand the need for future research activities, through the process of investigating the problem.	Apply
CO 4	Develop effectively the communication and presentation skills.	Apply
CO 5	Utilize their skills in usage of new documentation and prepare the presentation.	Create

iv) GENERAL GUIDELINES

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar. The panel of evaluators shall be decided by the HoD, comprising of one senior faculty, seminar coordinator, and seminar guide. During the seminar presentation of a student, all members of IEC shall be present.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC. The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

v) EVALUATION PATTERN

- Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).
- Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).
- Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).
- Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

vi) MARK DISTRIBUTION

Internal Evaluation only

Total Marks	**Seminar Guide**	**Seminar Coordinator**	**IEC**	
			Presentation	**Report**
100	20	20	40	20

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U49B	PROJECT PHASE I	PWS	0	0	6	6	2020

i) PREREQUISITE:

ii) COURSE OVERVIEW:

Project Phase I aims in applying engineering knowledge in practical problem solving. To foster innovation in design of products, processes or systems and develop creative thinking in finding viable solutions to engineering problems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify a contemporary issue in the field of engineering and design a methodology to solve the problem.	Apply
CO 2	Analyse data and propose a feasible and effective solution to the problem under all realistic constraints.	Analyse
CO 3	Identify the impact of the proposed solutions in a global, economic, environmental and societal context.	Apply
CO 4	Assess the solution for real life Civil Engineering problems, and to work effectively in a team, upholding the professional and ethical responsibilities.	Evaluate
CO 5	Develop the project work effectively in oral and written forms.	Apply

iv) SYLLABUS

Project Phase 1

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.

- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects**:**

Topic Selection: Innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student’s Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students’ thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same.Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have knowledge on the procedure to be adopted and the methodologies. However, the team has not made much progress in the design and yet to catch up with the project plan. .	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student shows some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design/feasibility study/ algorithm development (0 – 3 Marks)	The team has started doing some preliminary work with respect to the project. The students however are notprepared enough for the work and they need to improve a lot. (4 – 6 Marks)	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further. (7 - 9 Marks)	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and is poised to finish the phase I in an excellent manner. They have shown results to prove their progress. (10 Marks)

SEMESTER – VIII

Syllabus and Course Plan

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U40B	QUANTITY SURVEYING AND VALUATION	PCC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U28A CIVIL ENGINEERING PLANNING AND DRAFTING LAB

ii) COURSE OVERVIEW

The course provides knowledge about various types of estimation and specifications in different civil engineering works. It equips students to analyze the rate of various items of work with reference to the standard data and schedule of rate. This course develops capability of students to prepare a detailed estimate of various items of work related to civil engineering construction and also preparation of the valuation of land and buildings.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basic terms related to estimation, quantity surveying and contract document	Understand
CO2	Interpret the item of work from drawings and explain its general specification and unit of measurement	Understand
CO3	Make use of given data from CPWD DAR/DSR for calculating the unit rate of different items of work associated with building construction	Apply
CO4	Develop detailed measurement (including BBS) and BoQ of a various works like buildings, earthwork for road, sanitary and water supply works	Apply
CO5	Explain various basic terms related to valuation of land and building	Understand
CO6	Utilize different methods to perform valuation of a building	Apply

iv) SYLLABUS

Introduction- Quantity Surveying, Estimate, Contingencies, Introduction to the use of CPWD schedule of rates and Analysis of rate as per latest DAR Specifications, Detailed Estimate- Centre line method & Short wall long wall method, Material quantity calculation of the items of work, Bar Bending Schedule, Valuation, Depreciation, obsolescence.

v) a) TEXT BOOKS

1) Dutta, B. N., *Estimation and Costing in Civil Engineering*, CBS Publishers and Distributors Pvt. Ltd., 28th Edition, 2022.

2) Rangwala, *Estimation Costing and Valuation*, Charotar Publishing House Pvt. Ltd., 17th Edition, 2017.

3) Seetharaman, S. and Chinna Swami, M., *Estimation and Quantity Surveying*, Anuradha Publications, 2015.

4) Chakraborthy, M., *Estimating, Costing, Specification and Valuation*, Published by the Author, 21 B, Babanda Road, 2010.

b) REFERENCES

1) Patil, B. S., *Civil Engineering Contracts and Estimates*, Orient Blackswan Pvt. Ltd., 4th Edition, 2015.

2) Vazirani, V. N. and Chandola, S. P., *Civil Engineering Estimation, Costing, and Valuation*, Khanna Publishers, 6th Edition.

3) IS 1200 : 1968, *Methods of Measurement of Building and Civil Engineering Works*, Bureau of India Standards, New Delhi, 1968.

4) CPWD, *Analysis of Rates for Delhi - 2021*, Central Public Works Department, New Delhi, 2021.

5) CPWD, *Delhi Schedule of Rates - 2021*, Central Public Works Department, New Delhi, 2021.

6) CPWD, *Specifications – Volumes 1 & 2*, Central Public Works Department, New Delhi, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Quantity survey, basic principle, Role/responsibility of Quantity surveyor, Estimate-List the types, Details required. Types of estimates, simple problems of approximate estimate, purpose. Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity (Brief description only). Bill of Quantity -Typical format-use. Units of measurement of various materials and works. General rule & method of measurement with reference to Indian Standard Specifications-IS1200. Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR, Overhead charges, Cost index.	**10**
II	Specifications-General specification of various items of building work. Detailed specification of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of	**7**

	building work with reference to CPWD specifications.Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete. Works, finishing work, masonry work, stone works, flooring with reference to latest DSR and latest DAR (All data (Material, labour & machine) and rate will be given in the question paper)	
III	Preparation of detailed measurement and abstract of estimate using Centre line method & Short wall long wall (separate wall) method-Explain with a single room building example. Preparation of detailed measurement for RCC single storey buildings with stair cabin-Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. Preparation of BoQ of single storied RCC building. Material quantity calculation of the Rubble, Brick work, Concrete work, plastering in detailed estimate of RCC building (Data for unit quantity should be provided from DAR). BBS of RCC beams, slabs, Column footings, Retaining wall. Road estimation-Estimation of earthwork from longitudinal section. Estimation of sanitary and water supply work -Water tank, Septic tank , Manhole (Concept only)	**18**
IV	Valuation –Purpose, factor affecting- Introduction to terms-Value, Cost, Price, Income- Gross income, net income, outgoings, annuity, sinking fund (Simple Examples), Year's purchase, Depreciation, obsolescence -Free hold and leasehold properties. Depreciation – methods of calculating depreciation– straight line method, constant percentage method, sinking fund method, and quantity survey method-numerical examples. Methods of valuation of land with building – rental method, direct comparison of capital cost, valuation based on profit, depreciation method. Various method of valuation of land (Brief description only)	**10**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

PROGRAMME ELECTIVE - III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42A	ADVANCED DESIGN OF RCC STRUCTURES AND LIGHT GAUGE MEMBERS	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30B DESIGN OF CONCRETE STRUCTURES, CE1U40A DESIGN OF STEEL STRUCTURES

ii) COURSE OVERVIEW

The goal of this course is to make students competent with contemporary engineering practices related to advanced design of reinforced concrete structural members. It also deals with the design of light gauge steel members.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply the codal provisions in the design of retaining walls, and flat slab.	Apply
CO 2	Apply the codal provisions in the design of water tanks.	Apply
CO 3	Analyse the reinforced concrete slabs using yield line theory.	Analyse
CO 4	Apply the codal provisions in the design of light gauge sections.	Apply
CO 5	Analyse and design reinforced concrete continuous beams.	Analyse
CO 6	Analyse and design reinforced concrete portal frames.	Analyse

iv) SYLLABUS

Design - Retaining Structures, deep beams; Water tanks, Yield line method of analysis of slabs and flat slabs, Light gauge sections, Continuous beams, reinforced concrete portal frames.

v) a) TEXT BOOKS

1) Punmia, B. C, Jain A.K and, Jain A. K , *R C C Designs*, Laxmi Publications Ltd.,10e,2015.
2) Ramchandra S. and Virendra Gehlot, *Design of Steel Structures Vol. I and Vol. II*, Standard Book House, 2007
3) Varghese P. C., *Advanced Reinforced Concrete Design*,2nd Edition, Prentice Hall of India Pvt Ltd, 2009
4) N. Krishna Raju, *Advanced Reinforced Concrete Design*, 3rd edition, CBS Publishers & Distributors, 2020.

b) REFERENCES

1) Pillai S.U and Menon D., *Reinforced Concrete Design*, Tata McGraw Hill Book Co., 2009
2) N. Subramanian, *Design of Steel Structures: Limit State Method*, Oxford University Press, 2018
3) IS 456: 2000, *Indian Standard Plain and Reinforced Concrete - Code of practice*, Bureau of Indian Standards, New Delhi, 2000.
4) IS 875 (Part I) : 1987 (Reaffirmed 2018), *Code of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures Part 1 Dead Loads - Unit Weights of Building Material And Stored Materials (Incorporating IS 1911 : 1967)*, Bureau of Indian Standards, New Delhi, 2018.
5) IS 875 (Part II) : 1987 (Reaffirmed 2018), *Code of Practice for Design Loads (Other Than Earthquake) For Buildings And Structures: Part 2 Imposed Loads*, Bureau of Indian Standards, New Delhi, 2018.
6) IS 875 (Part III) : 2015 (Reaffirmed 2020), *Design Loads (Other than Earthquake) for Buildings and Structures - Code of Practice Part 3 Wind Loads*, Bureau of Indian Standards, New Delhi, 2018.
7) IS 875 (Part V) : 1987 (Reaffirmed 2018), *Code of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures Part 5 Special Loads And Combinations*, Bureau of Indian Standards, New Delhi, 2018.
8) IS 1893 (Part I) : 2016 (Reaffirmed 2021), *Indian Standard Criteria for Earthquake Resistant Design of Structures*, Bureau of Indian Standards, New Delhi, 2016.
9) IS 13920 : 2016 (Reaffirmed 2021), *Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – Code of Practice*, Bureau of Indian Standards, New Delhi, 2021.
10) SP 34 : 1987, *Handbook on Concrete Reinforcement and Detailing*, Bureau of Indian Standards, New Delhi
11) IS 801 : 1975 (Reaffirmed 2010), *Code of practice for cold framed light gauged steel structural members*, Bureau of Indian Standards, New Delhi, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Retaining Structures- Introduction- Functions and types of retaining walls- Structural analysis and design of RCC cantilever type of retaining wall for various types of backfill conditions, Counterfort retaining wall- design principles of components and detailing (design not required), Structural design of deep beams	9
II	Review of the IS code 3370 (2021), Introduction to design of water tanks-design philosophy and requirements-joints-IS code recommendations- Design of rectangular water tanks using IS code coefficients (IS 3370- 2021). Design of circular water tanks using IS code coefficients (IS 3370-2021)	9

III	Yield line method of analysis of slabs:– Characteristic features of yield lines– analysis by virtual work method – Yield line analysis by equilibrium method, Flat slabs – Introduction–components–IS Code recommendations– IS code method of design of interior panel (with and without column drop)	**9**
IV	Review of the codes –IS 811(1987), IS 801(1975),SP 6-5(1980) Light gauge sections – Types of cross sections – Local buckling and post buckling – Design of compression and Tension members – Design of flexural member-Types of connections and their design	**9**
V	Design of continuous beams– Redistribution of moments- Detailing Reinforced concrete portal frames: Introduction - Analysis and design of rectangular portal frames for vertical loading Approximate methods for structural Analysis and design for vertical loads , Pattern loading, lateral load.	**9**
	Total hours	**45**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42B	GEO-ENVIRONMENTAL ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING-I, CE1U20E ENVIRONMENTAL ENGINEERING

ii) COURSE OVERVIEW

Goal of this course is to introduce the role of geotechnical engineering in dealing with environmental problems related to the reduction of waste, waste disposal facilities and clean-up of contaminated sites.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify the geo-environmental considerations of waste containment	Apply
CO 2	Explain the contaminant transport mechanism	Understand
CO 3	Discuss the components of a sanitary Landfill	Understand
CO 4	Plan suitable remediation methods for contaminated sites	Apply

iv) SYLLABUS

Scope of geo-environmental engineering. Solid waste management rules –MoEF guideline. Geochemical Attenuation. Waste Characteristics of Municipal Solid Waste.

Contaminant Transport - Advection, Diffusion, Dispersion. Soil-water-contaminant interaction. Evolution of waste disposal facilities– Hydrological consideration in landfill design.

Containment technology, Landfill-Type-site selection. Landfill Components, layout and capacity. Types and functions of liner.

Primary and secondary leachate collection and removal systems. Cover System Components, Gas Management, Gas extraction systems.

Site characterization – risk assessment of contaminated site - remediation methods for soil and groundwater.

v) a) TEXT BOOKS

1) Reddi L.N and Inyang HI, *Geoenvironmental Engineering: Principles and Applications*, Marcel Dekker Inc Publication, 1st edition, (2000)

2) Hari D. Sharma, Krishna R. Reddy , *Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies*, Publisher: John Wiley & Sons Inc., 1st edition, (2004)
3) Donald L. Wise, Debra J. Trantolo, Hilary I. Inyang, Edward J. Cichon , *Remediation Engineering of Contaminated Soils*, Publisher: Marcel Dekker Inc, (2000)
4) Dr. G V Rao and Dr. R S Sasidhar, *Solid waste Management and Engineered Landfills*, Saimaster Geoenvironmental Services Pvt. Ltd. Publication., (2009)

b) REFERENCES

1) Daniel, D.E, *Geotechnical Practice for Waste Disposal*, Chapman and Hall, London, 1st edition (1993)
2) R. N. Yong *Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation,* Lewis Publication, (2000)
3) Ayyar TSR, *Soil engineering in relation to environment,* LBS centre for Science and Technology, Trivandrum, (2000)

vi) COURSE PLAN

Module	Contents	No. of hours
I	Scope of geo-environmental engineering – multiphase behavior of soil – role of soil in geo-environmental applications Importance of soil physics, soil chemistry, hydrogeology, biological process – impact of ground contamination on geoenvironment Regulatory requirement -Solid waste management rules (brief introduction only) –MoEF guideline Geochemistry-Geochemical Attenuation-Quantification of attenuation capacities. Laboratory evaluation, sequential batch-contact testing & Column percolation testing. Waste Characteristics of Municipal solid waste-Physical, Chemical & geotechnical. Identification of Hazardous and Non-Hazardous waste	9
II	Contaminant Transport- Transport process- Advection, Diffusion, Dispersion – Advection Dispersion equation -Fick's equation. Soil-water-contaminant interaction, Soil-water interaction and concepts of double layer Evolution of waste containment facilities and disposal practices – Site selection based on environmental impact assessment –Different role of soil in waste containment – Hydrological consideration in landfill design	9
III	Containment technology, Landfill-Type-site selection Landfill Components: Landfill layout and capacity, components of landfill and its functions.	9

	Types and functions of liner-natural clay liner, properties - Compacted clay liner- selection of soil for liner, properties-effect of compaction on permeability of clay. Geomembrane liners-Types-Geosynthetic clay liners , Type-methodology of construction, testing and design aspects.	
IV	Primary and secondary leachate collection and removal systems. Drainage, Collection, Removal and Filtration considerations of primary and secondary leachate collection and removal systems. Various components and design considerations. Cover System-Basic concept, Components-surface layer, Protection layer, Drainage layer, Barrier layer Assessment Gas Management, Gas extraction systems-passive and active system Closure and post closure monitoring system (brief introduction)	**9**
V	Site characterization – risk assessment of contaminated site - Remediation methods for soil and groundwater – selection and planning of remediation methods – In-situ / ex-situ remediation, bio remediation, thermal remediation, pump and treat method, phyto-remediation and electro kinetic remediation Stability of landfill (brief introduction), Soil exploration at contaminated site (brief introduction)	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42C	RAILWAY AND TUNNEL ENGINEERING	PEC	3	0	0	3	2020

i) COURSE-PREREQUISITE: Nil

ii) COURSE OVERVIEW

The goal of this course is to introduce the various aspects of railway and tunnel engineering, including its history, development, geometric design, construction, maintenance and safety aspects. The course also discusses the recent advances in railway engineering.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply Indian standard guidelines to design the geometric elements of a railway track.	Apply
CO 2	Explain railway operation and control systems.	Understand
CO 3	Explain the different steps in the maintenance of a railway track and the safety aspects of railways.	Understand
CO4	Illustrate the various methods of tunnelling.	Understand
CO 5	Outline the different aspects of drainage, ventilation, lighting and lining of tunnels.	Understand

iv) SYLLABUS

Introduction to Railways in India: Role of Indian Railways in National development – Railways for urban transportation – alignment, permanent way.
Typical cross-section - Component parts of a railway track - requirements and functions. Geometric design of railway track.
Railway operation and control. Signalling. Principles of track circuiting – control systems of train movements.
Maintenance of railway track. Railway accidents. Modern developments in railways.
Tunnel Engineering: Tunnel - sections - classification - tunnel surveying, tunnel driving procedure.
Tunnel lining, ventilation, drainage and lighting of tunnels.

v) (a) TEXT BOOKS

1) Srinivasan R, *Harbour, Dock and Tunnel Engineering*, Charotar Publishing House Pvt. Ltd., 30th Edition, 2022.
2) Saxena S C and Arora S P, *A Textbook of Railway Engineering*, Dhanpat Rai Publications, 8th edition, 2021 (Reprint).
3) Ketki B D, Rangawala K S, *Railway, Bridge and Tunnel Engineering*, Charotor Publishing House, 3rd edition, 2021.

(b) REFERENCES

1) Mundrey J S, *Railway Track Engineering*, Tata McGraw Hill, 5th edition, 2017.
2) Gayle B and Gayle R, *Handbook of Tunnel Engineering Design, Construction and Risk Assessment,* Knowledge Bakers, 1st edition, 2022.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Railways in India: Role of Indian Railways in National development – Railways for urban transportation – alignment, basic requirements and factors affecting selection, Typical cross-section. Permanent Way: Components and their functions - component parts of a railway track – requirements and functions – Rails – types of rails, rail fastenings, sleepers – functions, materials, density, ballast less tracks. Concept of gauges, coning of wheels, creeps and kinks – Gradients – different types – compensation of gradients, geometric design of railway track: horizontal curves, radius – super elevation – cant deficiency – transition curves.	**11**
II	Railway operation and control: points and crossings – design features of a turnout. Signalling – classification of signals, layout of signals, interlocking of signals and points. Principles of track circuiting – control systems of train movements – ATC, CTC.	**10**
III	Maintenance: Items of track maintenance, packing and over hauling, screening. Station yards and marshalling yards. Railway accidents: Human and system contribution to catastrophic accidents, human factors in transport safety. Modern developments- LRT &MRTs, tube railways, high speed tracks.	**8**
IV	Tunnel Engineering: Tunnel - sections - classification - tunnel surveying - alignment, transferring centre, grade into tunnel. Tunnel driving procedure. Tunnelling methods - shield method of tunnelling, compressed air method, tunnel boring machine.	**8**
V	Tunnel lining – necessity, materials, methods, ventilation – natural and mechanical ventilation. Drainage of tunnels, dust control methods.	**8**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42D	IRRIGATION AND DRAINAGE ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The general objective of this course is to make the students familiar with the concepts of irrigation water scheduling, distribution and system performance. The course aims to impart the knowledge on surface and sub-surface systems for drainage of irrigation lands and the principles behind the reclamation of saline soils.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the crop water requirement and the design of various surface irrigation methods.	Understand
CO 2	Explain scheduling of irrigation and irrigation system performance	Understand
CO 3	Illustrate properties of soil water zone and open drains	Understand
CO 4	Identify the design of various drainage systems	Apply
CO 5	Identify leaching requirement and design of drainage systems considering crop water requirement and leaching requirement	Apply

iv) SYLLABUS

Surface Irrigation methods: Classification, Crop Water Requirements, Irrigation Water Distribution: Canal network and canal regulation, surfaces and subsurface drainage-design considerations, Soil Water Zone, unsteady state drainage equations, Layout of open drainage systems - Sub-surface drainage systems, Salinity and drainage, Design of a drainage system

v) a) TEXT BOOKS

1) Peter Waller, Muluneh Yitayew, Irrigation and Drainage Engineering, Springer Cham, 2015.
2) Majumdar D K, Irrigation Water Management Principles and Practices, Prentice Hall of India,New Delhi, 2014
3) Michel A M, Irrigation Theory and Practice, Vikas Publishing House, New Delhi, 2008

b) REFERENCES

1) Ritzema H P, Drainage Principles and Applications, Publication No. 16, International Institute of Land Reclamation and Improvement, Netherlands, 2006
2) Allen R,Walter I,Elliott R, Howell T, Itenfisu D, Jensen M, Synder R , The ASCE standardized reference evapotranspiration equation, ASCE,Reston,p.192,2005

3) Allen R L, Pereira D R, Smith M, Crop Evapotranspiration-guidelines for computing crop water requirements, 1998,http://www.fao.org/docrep/X0490E/x0490e00.htm
4) Irrigation and Drainage paper 56. Crop water requirement. FAO, Rome, 1988.
5) Kessler J, Drainage Principles and Applications, Volumes I to IV, International Institute for Land Reclamation and Improvement (ILRI), Netherland s, 1979.
6) Irrigation and Drainage paper 24. Crop water requirement. FAO, Rome, 1977.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Surface Irrigation methods: Classification – Border irrigation: design parameters, evaluation and ideal wetting pattern – Furrow irrigation: design parameters, types of furrows, evaluation, ideal wetting pattern – Basin irrigation: types of basins, ideal wetting pattern, shapes and size – Efficiency of surface irrigation methods. Crop Water Requirements : Infiltration and movement of water in soil– Soil-water-plant relationship – Water requirement of crops – Evapo transpiration (ET) and consumptive use - Effective rainfall – Irrigation requirement, Soil water balance, Yield response to water, Production functions .	8
II	Irrigation Water Distribution: Canal network and canal regulation – Methods of distribution: supply based and demand based – Delivery of water to farms –Measurement of water – Scheduling of irrigation – Criteria for scheduling, constraints – Frequency and interval of irrigation. Irrigation System Performance Indicators: Systems classification –Rehabilitation and modernization – Performance indicators – Improving system performance –constraints. Land Drainage systems: necessity-types-surfaces and subsurface drainage-design considerations.	8
III	Soil Water Zone: Description, Flow through soil water zone-Physical properties of soil-hydraulic conductivity-saturated thickness-drainable pore space-storativity, hydraulic resistance, leakage factorGround water data-concepts of ground water hydrograph, ground water maps, Isobath map, water table fluctuation maps etc. Drainage studies-continuity equation, Laplace equation, relaxation method of solution-Typical boundary conditions like impervious layer, plane of symmetry, freewater surface, water at rest or slowly moving water, seepage surface- Dupit Forchheimer Theory steady flow above an impervious horizontal boundary-Dupits equation-water table subject to recharge. Flow into open drains-steady state equations-Hooghoudt equation, Principles, applications for design use of nomographs for homogeneous and layered soils– Earnst	10

	equation, concept of horizontal vertical and radial flow, application to layered soils.	
IV	Unsteady state drainage equations-Glover Dum equation, application, concept of Kraijenhoff Vande Leur Mass land equation, application- analysis for constant recharge, intermittent recharge cases. Layout of open drainage systems: types-Field drains, design considerations of ditch drains- Mole drains, design considerations, suitability- Sub-surface drainage systems- Pipe drainage systems design for uniform and non-uniform flow conditions-transport and dewatering situations. Patterns of drainage system- Drainage criteria formulation for off season drainage, crop season drainage, salt drainage- use of steady state and unsteady state approaches in formulation. - criteria for irrigated area. –incorporation of intentional and unavoidable losses	**10**
V	Salinity and drainage- cause of salinity, salt balance equation, leaching efficiency, salt equilibrium equation and leaching requirement – salt storage equation – expressing equations in electrical conductivity terms-Design of a drainage system for an irrigated area based on crop water requirement and leaching requirement- Dynamic equilibrium concept. Gravity outlet structures- types, location.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42E	CONSTRUCTION METHODS AND EQUIPMENT	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30E CONSTRUCTION TECHNOLOGY & MANAGEMENT

ii) COURSE OVERVIEW

This course introduces students to construction equipment and selected construction methods. This includes selection and technical fundamentals of common construction equipment and construction procedures for civil construction.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the various construction procedures for substructures and superstructures.	Understand
CO 2	Outline the various construction activities involved in underground and underwater construction.	Understand
CO 3	Make use of basic knowledge about construction equipment and machineries.	Apply
CO 4	Select the equipment for production of aggregates and concreting.	Apply
CO 5	Select construction equipment appropriate to tasks.	Apply

iv) SYLLABUS

Construction techniques- Techniques of construction for continuous concreting operation in tall buildings- Bridge Construction- Domes, Substructure construction- Tunnelling techniques- Piling techniques, Equipment for Earth Work- earth moving operations- trucks and hauling equipment- compacting equipment- finishing equipment, Equipment for production of aggregate and concreting- Crushers – Feeders - Screening Equipment – Handling Equipment- Batching and Mixing Equipment- Concrete Pouring and Pumping Equipment, Other construction equipment- Pile driving Equipment- Erection Equipment- Equipment for Dewatering and Grouting.

v) (a) TEXT BOOKS

1) Peurifoy, R.L., Schexnayder, C.J., Schmitt, R.L. and Shapira A., "Construction Planning, Equipment and Methods", McGraw-Hill, Singapore, 9th edition, 2018.
2) Sharma, S.C. "Construction Equipment and Management", Khanna Publishers, New Delhi, 1st edition, 2019.

3) Arora, S.P. and Bindra, S.P., Building Construction, Planning Techniques and Method of Construction, Dhanpat Rai and Sons, 2010.

(b) REFERENCES

1) Deodhar, S.V. "Construction Equipment and Job Planning", Khanna Publishers, New Delhi, 2012.
2) Irvine, J., Advanced Construction Techniques, California Rocketry, 1984.
3) Varma, M., "Construction Equipment and its planning and Application", Metropolitan Book Company, New Delhi, 1983.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Construction techniques Construction joints- movement and expansion joints –Vacuum Dewatering of Concrete Flooring – Techniques of construction for continuous concreting operation in Tall buildings – Slip Form techniques—Erection techniques of Tall structures, large Span Structures - Bridge Construction, Construction sequence and methods - Bow string bridges, cable stayed bridges - Launching techniques for heavy decks. Domes- Types — Construction sequence and methods in domes	9
II	Sub structure construction Tunneling techniques- Piling techniques - driving well and caisson - sinking cofferdam- cable anchoring and grouting. Driving diaphragm walls, sheet piles - shoring for deep cutting -well points -dewatering and stand by Plant equipment for underground open excavation.	9
III	Equipment for Earth Work Fundamentals of earth work operations - earth moving operations - types of earth work equipment - tractors, motor graders, scrapers, front end waders – excavating and earth moving equipment- dozer, excavators, rippers, loaders - trucks and hauling equipment, compacting equipment, finishing equipment.	9
IV	Equipment for production of aggregate and concrete Equipment for production of aggregate and concreting - Crushers – Feeders - Screening Equipment – Handling Equipment- Batching and Mixing Equipment- Transit mixers - Hauling, Concrete Pouring and Pumping Equipment -Transporters	9
V	Other construction equipment Pile driving Equipment - Erection Equipment – Cranes, Derrick Cranes, Mobile cranes, Overhead cranes, Traveller cranes, Tower cranes - Types of pumps used in Construction - Equipment for Dewatering and	9

	Grouting - Material Handling Conveyors –Industrial Trucks, Forklifts and related equipment.	
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42F	AIR QUALITY MANAGEMENT	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

The course is designed to provide engineering knowledge on air pollution, air quality monitoring and air pollution control strategies among students. It motivates the students in maintaining and improving the air quality of the environment and empowers learners to take appropriate actions to reduce the air pollution for the benefit of the society.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the sources, types and effects of indoor and outdoor air pollutants	Understand
CO 2	Identify the meteorological aspects of air pollutant dispersion and behaviour of plume	Apply
CO 3	Explain the different methods of ambient air quality monitoring system which supports an air quality management program	Understand
CO 4	Identify the various air pollution control strategies that can be undertaken to meet the air quality goals.	Apply

iv) SYLLABUS

Introduction- Air Pollution- History of air pollution episodes- Sources, types and effects of indoor and outdoor air pollutants.

Meteorological aspects of Air Pollutant Dispersion - Inversions- Types, Plume behaviour. Dispersion of Air pollutants-Plume dispersion theory

Air Quality Monitoring - Ambient air sampling - Ambient Air Quality standards- Emission Inventory.

Control of Air Pollutants- Particulate emission control methods, Gaseous emission control methods

v) (a) TEXT BOOKS

1) Rao, C.S., *Environmental Pollution Control Engineering*, New Age International (P) Ltd., Publishers, 3rd edition, 2018
2) Rao, M.N., & Rao, H.V.N., *Air Pollution*, Tata Mc Graw Hill Co. Ltd, Delhi, 2017

(b) REFERENCES

1) Zhang, Y., Hopke, P.K., Mandin, C., *Handbook of Indoor Air Quality*, Springer Singapore, 2022
2) Mudakavi, J.R., *Principles and Practices of Air Pollution Control and Analysis*, IK International Pvt. Ltd., 2013
3) Perkins, H.C, *Air Pollution*, McGraw Hill Publications, 2004
4) Bhatia, S.C., *Textbook of Air Pollution and Its Control*, Atlantic publishers, 2021
5) Mahajan, S.P., *Air Pollution Control*, Common Wealth of Learning, Canada, Indian Institute of Science, Bangalore, 2009

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction- Components of Environment- Definition –Air Pollution- History of air pollution episodes. Sources of Air pollution – Industrial Processes causing Air Pollution- Air Pollutants- Types of Air Pollutants- Criteria Pollutants.	9
II	Effect of air pollutants on health, vegetation, animals and materials and environment- Greenhouse effect, Indoor Air Pollution- Sources of indoor air pollutants- Effects of indoor air pollution.	9
III	Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships Atmospheric Stability- Temperature Lapse Rate- Inversions- Types, Plume behaviour. Dispersion of Air pollutants-Plume dispersion theory- Gaussian plume model (Derivation not required)- Assumptions- Advantages and Disadvantages- Pasquill's stability curves.	9
IV	Air Quality monitoring - Ambient air sampling - Collection of gaseous air pollutants-Collection of particulate Pollutants- Ambient Air Quality standards- Emission Inventory.	9
V	Control of Air Pollutants- Particulate emission control-methods, Scrubbing-Cyclones- Filtration- Electrostatic Precipitation, Gaseous emission control- adsorption, absorption, thermal methods.	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42G	URBAN PLANNING AND ARCHITECTURE	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of Architecture and Urban Planning. After this course, students will be able to understand the visual vocabulary and origin and evolution of Architecture and Urban Planning and its impact in the society

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Classify the elements of architecture and fundamental principles of architectural design.	Understand
CO 2	Discuss the origin and evolution of World Architecture, Indian Architecture and Architecture of Kerala.	Understand
CO 3	Explain the basic principles of sustainability and resource-based planning.	Understand
CO 4	Explain the evolution of planning and impact of urbanization.	Understand
CO 5	Explain different town planning regulations and guidelines.	Understand

iv) SYLLABUS

Architecture: definition – factors influencing, Principles and elements.

Characteristic features of a style – Characteristic features and examples from world architecture**,** Characteristics of Gothic churches and cathedrals, Renaissance: development of stone vaults into groined systems, Indian architecture, Introduction to Kerala Architecture, Evolution of architectural style.

Basic concepts of sustainability- goals for sustainable development- Introduction to the concept, basic concept of Green Buildings, Sustainable building practices in India, Resource based planning.

Basics of planning, Benefits of planning, beginning of town planning acts, Basics of town planning surveys, Land use surveys and analysis.

Regional planning, Zoning and subdivision regulation,. Types of plans, Spatial standards, URDPFI guidelines, New Urbanism and Public participation in planning process.

v) (a) TEXT BOOKS

1) Simon, U., Analysing Architecture, Routledge Publications, Taylor and Francis, 5th edition, 2020.

2) Ching, F. D. K., Jarzombek, M. M. and Prakash, V., A Global History of Architecture, Wiley & Sons Publication, 1st edition, 2010.
3) Roth, L. M. and Clark, A. C. R., Understanding Architecture-Its Elements, History and Meaning, Westview Press, 3rd edition, 2013.

(b) REFERENCES

1) Urban and Regional Development Plan Formulation and Implementation Guidelines, Ministry of Urban Affairs, Govt. of India, 2014.
2) Kulshrestha, S. K., Urban and Regional Planning in India: A handbook for professionals, 2012.
3) Ching, F. D. K., A Visual Dictionary of Architecture , John Wiley and Sons Publication, 2nd edition, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Architecture: definition – factors influencing architectural development-Principles and elements of architecture: Contrast, proportion, scale, balance, rhythm, character, colour and unity- Line, space, form and shape.	9
II	Characteristic features of a style – Characteristic features and examples from world architecture. Development of Roman vocabulary of Architecture, Structural and Engineering feats - Geometry and Greek Architecture, Greek Capitals and Orders. Gothic: Characteristics of Gothic churches and cathedrals, Renaissance: development of stone vaults into groined systems. Indian architecture: A brief study of the architecture of Buddhist, Hindu and Indo-islamic period. Introduction to Kerala Architecture: Evolution of architectural style, Factors that influenced the development of Kerala architecture: Materials, Climate & Socioeconomic factors.	9
III	Basic concepts of sustainability- goals for sustainable development- Introduction to the concept and issues of Sustainable Architecture - basic concept of Green Buildings- Green Rating systems (LEED and GRIHA) - Sustainable building practices in India. Resource based planning – urban infrastructure planning in sustainability context- socioeconomic development and sustainable planning – sustainable new towns.	9
IV	Basics of planning: Evolution of towns – problems of urban growth – Benefits of planning - urbanization, industrialization and urban development; push and pull factors; migration trends and impacts on urban and rural development – beginning of town planning acts – ideal towns – garden city movement – concept of new towns and conservative surgery - comprehensive planning of towns. Basics of	9

	town planning surveys – Land use surveys and analysis – Socio-economic surveys.	
V	Regional planning – Zoning and subdivision regulation – FSI/FAR – Neighbourhood planning – planning principles – site planning – site selection criteria for housing development – types – site analysis. Types of plans – master plans, development plans, etc. (introduction only). Spatial standards, performance standards, benchmarks, and variable standards; URDPFI guidelines, zoning regulations/ordinances and DCR and (development control rules and regulations). New Urbanism and Public participation in planning process.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U42H	WIND ANALYSIS ON STRUCTURES, CLADDING AND GLAZING COMPONENTS	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to familiarise the student with the effects of wind loading in buildings and other structures such as bridges, steel transmission line towers and cooling towers. The concepts learned will help them analyze the structure for the given wind force condition per the codal provisions. It also enables the students to undertake sustained learning on wind tunnel testing.

iii) COURSE OUTCOMES

After completing the course, the student will be able to:

CO 1	Explain the characteristics of wind and Bluff body aerodynamics.	Apply
CO 2	Make use of static and dynamic wind effects on structures	Apply
CO 3	Explain the effect of wind on building structures, cladding and glazing.	Apply
CO 4	Analyse the structures, claddings and glazing subjected to wind load	Analyse
CO 5	Explain the role of wind tunnel testing on structures	Apply

iv) SYLLABUS

Nature of wind storm, Design wind speed, Atmospheric boundary layer and Wind turbulence. Basic Bluff body aerodynamics, Wind effects on Low Buildings, Wind effects on Tall Buildings, Design forces on multi-story buildings, towers, cladding and roof trusses, Wind load calculation on special structures such as cooling towers, rail/road bridges and tall chimneys, Role of Wind Tunnel, Modelling, Tornado effects.

v) (a) TEXT BOOKS

1) Holmes, J. D., Wind loading of structures, CRC Press, 4th edition, 2022.
2) Sachs, P., Wind Forces in Engineering, Pergamon Press, New York, 2nd edition, 2013.
3) Simiu, Emil; Yeo, DongHun, Wind effects on Structures- Modern Structural Design for Wind, John Wiley & Sons, 4th Edition, 2019
4) Lawson, T. V., Wind Effects on Buildings, Vols. I and II, Applied Science and Publishers, London, 1993.

5) Devenport, A. G., Wind Loads on Structures, Division of Building Research, Ottowa, 1990.

(b) REFERENCES

1) Scruton, C. P., An introduction to wind effects on structures (Vol. 3), Oxford University Press, 1981.
2) Sachs, P., Wind forces in engineering, Elsevier, 2013.
3) Dyrbye, C. and Hansen, S. O., Wind loads on structures, John Wiley & Sons, 1996.
4) Simiu E and Miyata T, Design of buildings and bridges for wind: a practical guide for ASCE-7 standard users and designers of special structures, 1st edition, Wiley, 2006.
5) IS 875 (Part 3): 2015 - Design Loads (Other than Earthquake) for Buildings and Structures - Code of Practice - Wind Loads (Third Revision), Bureau of Indian Standards, New Delhi.
6) AS 1288-2006: Glass in buildings- selection and installation, Australian Standard

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Characteristics of wind, Nature of wind storm, types of winds, Extreme wind conditions, Design wind speed, Atmospheric boundary layer and Wind turbulence. Basic Bluff body aerodynamics: Flow around bluff bodies, Pressure & force coefficients flow around flat plates, Walls, Prismatic shapes.	**9**
II	Static wind effects-drag coefficient, lift coefficient. Dynamic wind effects - along wind load, across wind load, flutter, galloping, buffeting. Interference effects (concept only) – Rigid structure – Aeroelastic structure (concept only)	**9**
III	Effect on typical structures: Wind effects on roof and cladding, Wind effects on Low rise buildings: Low buildings with different roof shapes and multi-span buildings. Wind effects on tall buildings: Along wind effects, Across wind effects and vortex shedding. Wind effect on chimneys, towers, bridges and structural glazing.	**9**
IV	Wind load calculations as per IS 875 (Part 3) - Application to design: Design forces on multi-storey buildings, towers, cladding and roof trusses. Wind load calculation on special structures such as cooling towers, rail/road bridges, tall chimneys and structural glazing.	**9**
V	Wind Tunnel: Role of Wind Tunnel-Flow simulation, Modelling, Flow measurement, Pressure measurement, Deformation measurement. Basic considerations, Tornado effects.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

PROGRAMME ELECTIVE - IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43A	BRIDGE ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30B DESIGN OF CONCRETE STRUCTURES, CE1U40A DESIGN OF STEEL STRUCTURES

ii) COURSE OVERVIEW

This course introduces code of practices and standards for bridge design and covers conceptual planning and structural design of RCC and PSC bridges. A brief overview of structural analysis methods for superstructure, types of bearings and design of substructures and foundation are also covered in this course.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain components of bridges and selection of type of bridge based on the site condition.	Understand
CO 3	Apply different methods to determine the response of the bridge under various loading.	Apply
CO 4	Make use of relevant code provisions to design different types of bridges.	Apply
CO 5	Apply different code provisions to design Substructure, foundation and bearing for bridges.	Apply

iv) SYLLABUS

General Arrangement Design: Classification of Bridges - Codes of practices- Types and functions of Bridge Elements - Site selection - Bridge Aesthetics - Bridge Deck Analysis- Design of RCC deck slab, T-beam and slab, box girder, balanced cantilever bridge, Analysis and design of prestressed concrete bridge, Design of substructure and foundation, bearings.

v) a) TEXT BOOKS

1) Victor D. J., *Essentials of Bridge Engineering*, 6th Edition, Oxford, IBH publishing Co. Ltd, 2019.
2) Rajagopalan N., *Bridge Superstructure*, Narosa Publishing House, 2006.
3) Raju, N. K., *Design of Bridges*, Oxford and IBH Publishing Co.Pvt. Ltd., 5th Edition, 2019.

b) REFERENCES

1) IRC: 5-2015, *Standard Specifications and Code of Practice for Road Bridges, Section-I General Features of Design (Eighth Revision)*, Indian Road Congress, New Delhi, 2015.
2) IRC: 6-2017, *Standard Specifications and Code of Practice for Road Bridges, Section-II Loads and Load Combinations (Seventh Revision),* Indian Road Congress, New Delhi, 2017.

3) IRC: 22-2015, *Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design) (Third Revision),* Indian Road Congress, New Delhi, 2015.
4) IRC: 112-2020, *Code of Practice for Concrete Road Bridges*, Indian Road Congress, New Delhi, 2020.
5) IRC: 78-2014, *Standard Specifications and Code of Practice for Road Bridges, Section VII-Foundations and Substructures*, Indian Road Congress, New Delhi, 2014.
6) IRC: 83, 2018, Part II, *Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings (Elastomeric Bearings),* Indian Road Congress, New Delhi, Second Revision, 2018.
7) IRC:SP:105-2015, *Explanatory handbook to IRC: 112-2011 Code of Practice for Concrete Road Bridges,* Indian Road Congress, New Delhi, Second Revision, 2015.
8) IS 456-2000, (Reaffirmed 2005), *Plain and Reinforced Concrete Code of Practice*, Bureau of Indian Standards, New Delhi, 2005.
9) Raju, N. K., *Prestressed Concrete Bridges*, CBS Publishers & Distributors, Mc-GrawHill Education, 6th edition, 2018.
10) Baker, R. M. and Puckett, J. A., *Design of Highway Bridges an LRFD Approach*, 4th Edition, Wiley Publications, 2021.
11) Vazirani, V.N. Ratvani, M.M. and Aswani, M.G., *Design of Concrete Bridges*, Khanna Publishers, 5th Edition, 2006.
12) Hambly, E. C., *Bridge Deck Behaviour*, 2nd Edition, CRC Press, 2019 .
13) Ponnuswamy, S., Bridge Engineering, 4th Edition, McGraw-Hill Education (India) Pvt Limited, 2008.
14) Saran, S., *Analysis and Design of Substructures: Limit State Design*, Oxford and Publishing Co. Pvt. Ltd., 2018.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Classification of Bridges – based on function, span range, material, construction methodology. Functions of bridge elements. Criteria for site selection for bridges. Planning of bridge alignment and approaches. Geometric design considerations – number of lanes, width, gradient, superelevation, clearances for bridges. Geotechnical considerations – selection of foundation type. Hydraulic Design – calculation of design discharge, linear waterway and maximum scour depth. Considerations for Span Arrangement –economic span ranges, navigation requirement. Introduction to Bridge Aesthetics. Preparation of typical General Arrangement Drawing.	8

	Loads on bridges as per codal provisions - Vehicle Load with impact and braking effects -Wind load – Temperature, shrinkage and creep effects - Earth pressure - Water current force - Seismic effect.	
II	Bridge Deck Analysis: Simplified deck analysis and load distribution methods (Pigeaud, Courbon, Morrice-Little, Hendry- Jaegar methods) Limit State Design concepts as per IRC: 112. Load combination principles for Serviceability Limit State (SLS) and Ultimate Limit State (ULS) as per IRC: 6. R. C. Bridges: Design of R. C bridge decks-slab bridges- Straight and skew slab bridges - Design of T beam bridges Detailing of primary reinforcements as per IRC: 112.	**10**
III	Other Types of Bridges: Introduction - continuous girder bridges, rigid frame bridges, arch bridges, suspension bridges and cable stayed bridges Box girder bridges: Design of box girder (Single cell only) Balanced Cantilever Bridge: Design of Balanced cantilever bridge	**9**
IV	Design of PSC Bridges: Basic concepts of design for prestressing as per IRC: 112, Calculation of immediate and time dependent prestress losses. Cable profiling within limiting zone for no tension stresses. Design procedure for PSC I girder composite with RCC slab: Calculation of reinforcements for shear and torsion at ULS. Verification of stress, crack width and deflection at SLS.	**8**
V	**Design of Substructures and Foundation:** Types of Bearings as per IRC: 84: Functions and components of metallic bearings, Elastomeric bearing. Design of Substructures as per IRC: 78: Calculation of main reinforcement for abutment and pier. Design of Open and Well foundations as per IRC: 78: Stability analysis and design for flexure and shear at ULS and SLS. Design of Pile foundations as per IRC: 78: Design of pile cap and piles for vertical and lateral loads. Calculation of main reinforcement.	**10**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43B	ADVANCED FOUNDATION DESIGN	PEC	3	0	0	3	2020

i) **PRE-REQUISITE:** CE1U30C GEOTECHNICAL ENGINEERING -II

ii) COURSE OVERVIEW

Goal of this course is to impart to the students in-depth knowledge about the basic concepts and theories of foundation design. After this course the students will be able to understand and apply the design considerations to satisfy the major and other requirements of the geotechnical design of foundations.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain safe bearing capacity of shallow foundations of various shapes and on layered soil.	Understand
CO 2	Make use of suitable design of pile foundations using guidelines, settlement evaluation of pile groups , uplift capacity of single and group of piles in clay.	Apply
CO 3	Determine the load carrying capacity of under reamed piles and load capacity and uplift resistance of drilled piers.	Apply
CO 4	Determine the deflection and ultimate load capacity of vertical piles under lateral loading.	Apply
CO 5	Design cantilever sheet pile walls in clay and sand as per different codes of practices.	Apply
CO 6	Design concepts of machine foundations.	Analyse

iv) SYLLABUS

Bearing capacity of shallow foundations-IS code formula - Numerical problems- Footings subjected to Moments-Numerical problems- -Allowable bearing pressure from SPT N-values – Numerical problems -Footings on layered soil (concept only)

Deep foundations- - Geotechnical Design of Piles from SPT and CPT-Values-Numerical Problems-Settlement of pile groups in clay and sand- equivalent raft Approach-Numerical problems-

Settlement of pile groups in sand- Skempton's Method- Meyerhof's method- Numerical problems- Uplift capacity of single piles and group of piles in clay -Numerical problems.

Under reamed piles – Load capacity in sand and clay-design considerations as per IS– numerical problems- Drilled piers (straight shafted and belled) in clay- Design Considerations- Load Transfer Mechanism - Vertical Bearing Capacity and uplift capacity of belled Pier- Numerical problems.

Behaviour of vertical piles under lateral loading, Pile resistance and deflection under lateral loads, IS and Brom's method, IS lateral load test on vertical piles- numerical problems.

Sheet pile Walls-Types of sheet pile Structures-Design of cantilever Sheet pile wall in clay and sand -Numerical Problems-Anchored bulkheads –fixed earth and free earth support (concept only). Machine foundations- Types of Machine foundations, basic definitions, degree of freedom of a block foundation, general criteria for design of machine foundation, free and forced vibrations, vibration analysis of a machine foundation, determination of natural frequency, vibration isolation and control.

v) (a) TEXT BOOKS

1) Swami Saran, Analysis and design of substructures, Oxford & IBH publishing Co.PVt.Ltd NewDelhi,2013
2) P.C. Varghese, Foundation Engineering, PHI Learning Private Limited, M-97, 2012
3) Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010.
4) Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.

(b) REFERENCES

1) Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.
2) Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Indersley (India) Pvt. Ltd., 2013
3) Murthy V.N.S, Geotechnical Engineering: Principles and practices of Soil Mechanics and Foundation Engineering, New York: Marcel Dekker, 2003.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Bearing capacity of shallow Foundations-Review of terminology-IS code formula for safe bearing capacity of shallow foundation Numerical problems. Footings subjected to moments-effective width concept- Numerical Problems Allowable bearing pressure from N Value-Teng's equations for safe bearing capacity of strip, square and circular footings, Safe bearing pressure for a permissible settlement Numerical problem- Footings on layered soil concept with explanation	**9**
II	Deep foundations- Geotechnical Design of Piles from SPT and CPT - values-number and Spacing-Numerical Problems Settlement of pile groups in clay-equivalent raft concept Numerical problem Settlement of pile groups in sand- Skempton's method Meyerhof's method-Numerical problem Uplift capacity of single piles and group of piles in clay -Numerical problems	**9**
III	Under reamed piles-ultimate load carrying capacity in sand and clay-design considerations as per IS-IS formula-single and double bulb - Numerical problems- Drilled piers (straight shafted and belled) in clay- Design-Considerations- Load Transfer Mechanism Vertical Bearing Capacity and uplift capacity of belled pier - Numerical problems	**9**

IV	Behavior of vertical piles under lateral loading – Failure mechanisms of short piles in cohesive and granular soils for restrained and unrestrained conditions, given by (Broms) Failure mechanisms of long piles in sand and clay both free headed and fixed headed given by Broms- Empirical Methods to Determine Lateral Strength of Piles-IS 2911 and Brom's method- IS2911 method-concept and assumptions made- Criteria for classification of piles into short rigid piles or long elastic piles:Lateral load test on vertical piles. Details of Broms Method- Chart for estimating the ultimate lateral resistance of short and long piles in clayey soils Chart for estimating the lateral deflection at ground level for piles in Clayey soils under working loadsgiven by Broms. Chart for estimating the ultimate lateral resistance of short and long piles in sandy soils and Chart for estimating the lateral deflection at ground level for piles in Clayey soils under working loads given by Broms. Numerical problems using Brom's charts alone	**9**
V	Types of Sheet Pile Walls-Cantilever Sheet Pile Walls -Cantileversheet pile walls with cohesion less backfill-deflection diagram-depth of embedment Cantilever sheet pile walls with cohesive backfill- depth of embedment- Numerical problem- Anchored sheet pile walls-free earth support and fixed earth support analysis (concept only)-Rowe's moment reduction factor Machine foundations- Types of Machine foundations, basic definitions, -degree of freedom of a block foundation- general criteria for design of machine foundationsFree vibration without damping –Spring mass system-free vibration with damping- Forced vibrations without damping Vibration analysisof a machine foundation-determination of parameters required – Natural frequency of foundation soil system-Barken's method- Numerical problems Vibration isolation-active and passive isolation- vibration control	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43C	TRANSPORTATION PLANNING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

Goal of this course is to introduce to the students the concept of transportation planning and impart in-depth knowledge on the four stage planning process and to highlight the need for sustainable transportation.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Identify the need for transportation planning, the challenges related to transportation and its interaction with urban structure and land use.	Apply
CO 2	Explain the concept of travel demand and its role in transportation planning.	Understand
CO 3	Apply standard techniques for the collection of data used in four-stage planning process.	Apply
CO 4	Apply standard procedures for the four stage modelling in transportation planning.	Apply
CO 5	Outline the concepts of land use transport models, sustainable approaches to transportation planning and comprehensive mobility plan.	Understand

iv) SYLLABUS

Introduction, Urban travel characteristics, issues and challenges, detrimental effects of traffic on environment, Urban structure. Hierarchy of transportation facilities, transportation and land use.

Urban transport demand, modelling based on consumer behaviour of travel choices.

Basic principles of travel demand analysis and assumptions, systems approach to planning.

Stages of transportation planning process, Trip-based and Activity-based approaches, selection of study area, zoning, sampling techniques, data collection methods.

Trip generation, trip distribution, modal split, traffic assignment.

Land use models, Comprehensive Mobility Plan, sustainable transportation, transport demand management, quick response techniques.

v) a) TEXT BOOKS

1) Kadiyali L R, *Traffic Engineering and Transport Planning*, Khanna Publishers, 9th edition, 2018.
2) Khisty C J and Lall B K, *Transportation Engineering –An Introduction*, Pearson Education, 3rd edition, 2017.
3) Papacostas C and Prevedouros P, *Transportation Engineering and Planning*, Prentice Hall, 3rd edition, 2015.

REFERENCES

1) Meyer M D and Miller E J, *Urban Transportation Planning: A Decision Oriented Approach*, McGraw Hill, 2nd edition, 2001.
2) Hutchinson B G, *Principles of Urban Transport Systems Planning*, Mc-Graw Hill, Original edition, 1974.
3) Garber N J, and Hoel L A, *Traffic and Highway Engineering,* Cengage Learning, 5th edition, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Need for transportation planning- Characteristics of urban travel, transportation issues and challenges, detrimental effects of traffic on environment. Urban Structure- types and properties - centripetal, grid, linear, directional, movement and accessibility – hierarchy of transportation facilities. Transportation and land use - Role of urban activity analysis in transportation planning, Transportation impacts on activity system, Land use transportation interaction.	**8**
II	Role of demand analysis in transportation planning- Classification of urban transport demand and factors affecting demand, modelling based on consumer behaviour of travel choices. Basic principles of travel demand analysis and assumptions. Transportation planning process - Systems approach, elements/stages of transportation planning process - goal, objectives and constraints, Trip-based and Activity-based approaches for transportation planning.	**9**
III	Data collection – Definition of study area, zoning- selection of cordon, sampling techniques and sample size, sources of data and types of surveys for planning, evaluation of survey accuracy. Trip Generation- Factors influencing grip generation, methods of forecasting trip generation rates- expansion factor, linear regression, category analysis.	**10**
IV	Trip Distribution - growth factor methods, synthetic methods- gravity models, opportunity model. Modal Split - factors influencing modal split, types of mode split models – trip end, trip interchange, logit model.	**9**

	Traffic assignment- purpose, elements of transportation networks- nodes and links, methods for traffic assignment.	
V	Land use models- Selection of land use model, Lowry model- Structure, features, Model equation system. Sustainable transportation - features, facilities, transit oriented development, non-transport solutions to transport problems, Transportation demand management, quick response techniques for demand estimation. Comprehensive mobility plan- objectives and activities involved, Application of GIS in transport planning.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43D	INFORMATICS FOR INFRASTRUCTURE MANAGEMENT	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

This course is aimed at exposing the students to the scope of Informatics and Internet of Things (IoT) in Civil Engineering. It introduces students to the fundamentals of data analytics, informatics & IoT as it is applicable to the civil engineering field.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of data science, informatics & internet of things.	Understand
CO 2	Identify the use of geomatics in planning and site selection of infrastructure projects	Apply
CO 3	Apply building informatics in construction, monitoring and project management.	Apply
CO 5	Utilize IoT technology in infrastructure management.	Apply

iv) SYLLABUS

History of informatics, DIKW pyramid, data management- data types, Meta data, database management systems, Data analysis techniques-spatial and non-spatial data, trends and patterns

Fundamental concepts in Geo-informatics- Components, Spatial data and attributes, vector and raster data models, Vector data analysis-buffering, overlay; Raster data analysis- local operations, neighbourhood operations, zonal operations

Application of geo-informatic systems: Site suitability analysis- Residential area, Industrial area and a Reservoir. Zoning- Groundwater potential zonation, Hazard zonation Network Analysis- Water supply line, Power line and a Road network

Building Information Modelling- Definition, Elements of BIM, steps in BIM development, COBie standard, potential and applications of BIM

IoT Standards & Protocols, Concept of IoT in civil engineering- Applications in construction, product monitoring and project Management, Management Applications- Traffic Regulation, Water Supply and Smart Buildings

v) (a) TEXT BOOKS

1) J. Campbell, Essentials of Geographic Information Systems, Saylor Foundation,2nd edition 2017.
2) Ramez Elmasri, Shamkant B.Navathe, "Fundamental of Database Systems", Pearson Addison Wesley,7th edition 2017.
3) BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, Publisher: John Wiley & Sons; 2nd edition, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	History of informatics, DIKW pyramid & Meta data, Data management, Data types & Metadata, Database management systems, Data analysis techniques, Trends & Patterns in data analysis	9
II	Fundamental concepts in Geo-informatics- Components of GIS, Spatial data and attributes, Data models- vector & raster, Vector data analysis, Raster data analysis- local & neighbourhood analysis, Raster data analysis- zonal analysis.	9
III	Site suitability analysis for Residential area, Site suitability analysis for Industrial area, Site suitability analysis for reservoir, Ground water potential zonation & Hazard zonation mapping, Network analysis for water supply, Network analysis for power line, Network analysis for road network.	9
IV	Building Information Modelling- Definition, Elements of BIM, Steps in BIM development, COBie standard, Potential & applications of BIM.	9
V	IoT Standards & Protocols, Concept of IoT in civil engineering, Application of IoT in construction, product monitoring & project management, Management applications of IoT- Traffic, water supply, smart buildings	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43F	REMOTE SENSING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

This course introduces students to the concepts of remote sensing and its applications in environmental monitoring. They will learn basic terminology and physics of remote sensing, characteristics of sensors and image processing fundamentals. The students will also explore how satellite based remote sensing plays a significant role in monitoring land, vegetation, soil, air and water resources.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Discuss the principles of remote sensing	Understand
CO 2	Explain the concepts of image processing, data products and algorithms useful in remote sensing	Understand
CO 3	Discuss the role of remote sensing in monitoring land, vegetation and soil	Apply
CO 4	Identify the applications of remote sensing in air and water	Apply

iv) SYLLABUS

Physics of remote sensing, types of remote sensing, principles of image processing, Remote sensing of land, soil and vegetation, Atmospheric remote sensing, Remote sensing of water resources, water quality monitoring, flood monitoring, ocean monitoring, aquatic biodiversity mapping, oil spill detection.

v) (a) TEXT BOOKS

1) Hamlyn G Jones and Robin A Voughan, *Remote sensing of vegetation: Principles Techniques, and applications*, Oxford University Press, 2010.
2) George Joseph and Jeganathan C., *Fundamentals of remote sensing*, University Press, 3rd Edition, 2018

(b) REFERENCES

1) Sabins F.F. Jr., *Remote Sensing Principles and Interpretation*, W.II. Freeman and Company, 1978.

2) Martin, R.V., Satellite remote sensing of air quality, Atmospheric Environment, Vol 42(34), pp 7823-7843, 2008.
3) Lillesand T.M. and Kiefer R.W., R*emote sensing and image interpretation*, John Wiley and Sons, 2nd edition, 1987.
4) Seelye Martin, *An introduction to ocean remote sensing*, Cambridge University Press, 2014
5) Ravi Sankar Dwivedi, *Remote sensing of soil*s, Springer, 1st Edition, 2017.
6) Prasad S., and Thenkabail, *Remote sensing of water resources, disasters and urban studie*s, CRC Press, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Physics of remote sensing, interaction of earth surface features with electromagnetic radiations, atmospheric windows, effects of atmosphere, spectral signatures. Types of remote sensing, active and passive measurements, platform characteristics, satellite orbits, Some popular satellite Sensors-Landsat, MODIS, Sentinel, SCATSAT and INSAT 3D R	9
II	Sensor characteristics-spatial, temporal, spectral, radiometric resolutions, principles of image processing, methods of encoding image data-BIL, BIP, BSQ, False Colour Composite (FCC), elements of visual image interpretation, image correction techniques-atmospheric, geometric and radiometric, principles of photogrammetry, algorithms and data products	9
III	Remote sensing of land, soil and vegetation: Analysis of land surface biophysical properties, land surface temperature, classification of land use and land cover-supervised and unsupervised techniques, change detection, development of terrain models-DEM &DTM, soil type and soil moisture monitoring, vegetation indices, classification of vegetation using satellite data, detection of biomass burning	9
IV	Atmospheric remote sensing: Interaction of EM radiations with aerosols and gases- scattering, absorption and extinction, radiative transfer models and retrieval algorithms, aerosol optical depth, air quality monitoring using satellite data, LIDAR measurement of atmospheric profiles, meteorological monitoring and forecast	9
V	Remote sensing of water resources: Mapping water resources-surface and groundwater, watershed health assessment, water quality monitoring, flood monitoring, ocean monitoring, aquatic biodiversity mapping, oil spill detection	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U43G	BUILDING SERVICES	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30G ENVIRONMENTAL ENGINEERING

ii) COURSE OVERVIEW:

The course aims to provide a basic understanding about the various building services and enable the students to apply them in building planning and construction.

iii) COURSE OUTCOMES

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

CO 1	Explain the different water management services	Understand
CO 2	Choose an appropriate waste management system	Apply
CO 3	Identify suitable electrical and mechanical building services	Apply
CO 4	Identify the various firefighting services	Apply
CO 5	Choose relevant materials and practices for good acoustics	Apply
CO 6	Select suitable sustainable construction materials, methods and practices	Apply

iv) SYLLABUS

Water management services
Pipes for water distribution. Joints Water storage tanks: capacity and location. Water purifiers Terminology. Principles of water supply in buildings. Rain water Harvesting

Liquid and solid waste management services
Types of traps and chambers. Types of pipes and joints. Design principles of sanitary layout. Building sanitation systems. Decentralized treatment systems for multistoried buildings. Recycling grey water: practices Solid waste quantity, Types and composition, characteristics, on-site processing and disposal methods

Electrical and Mechanical services
Electrical installations and Accessories of wiring (terminologies and symbols only), Systems of wiring, Electrical layout for residence, Air Conditioning: Types of Air Conditioners. Types of Lifts, Location, Sizes, Component parts. Uses of different types of elevators.

Fire and Acoustic management services

Causes and Effects of fire, General Requirements of Fire Resisting building as per IS and NBC 2005, Characteristics of Fire resisting materials. Requirement of good Acoustic - Factors to be followed for noise control in residential building – Acoustical Materials.

Miscellaneous services

Concept of Green buildings – Sustainable features of Green building – LEED India rating system - Green materials and equipment - waste reduction during construction, HVAC Concept of building automation - Design issues related to building automation and its effect on functional efficiency.

v) a) TEXT BOOKS

1) Birdie, G. S., and Birdie, J. S., Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi, 9th Edition, 2010.
2) Duggal, K. N., Elements of Environmental Engineering, S Chand and Co. Ltd., New Delhi, Revised Edition, 2008.
3) Modi, P. N., Sewage Treatment and Disposal and Wastewater Engineering, Standard Book House, New Delhi, 17th Edition, 2020.
4) Raina. K. B and Bhattacharya.S. K, Electrical design estimating and costing, New age international pvt. Ltd publishers, 2nd Edition,2005.

b) REFERENCE BOOKS

1) Arora C.P, Refrigeration and Air Conditioning, Tata McGraw Hill, 2000
2) Charles J Kibert, Sustainable construction – Green building design and delivery, Wiley, Fourth Edition, 2016.
3) Curd, E. F. and Howard. C .A, Introduction to building services, Macmillan, 2nd Edition, 1996
4) Rainwater harvesting and conservation manual, CPWD, GOI, 2002

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Water management services** Pipes for water distribution, joints, fixtures and valves, water meters, etc. - Water storage tanks: capacity and location - water purifiers Terminology such as flow, pressure, head, etc. - principles of water supply in buildings (low-rise, multi-storeyed) Rain water Harvesting - roof top harvesting, type of spouts, sizes of rainwater pipes, methods of rainwater harvesting – harvesting tanks and pit - typical details	7
II	**Liquid and solid waste management services** Types of traps and chambers: inspection chamber, disconnecting chamber, intercepting trap, S trap, P-trap, gully trap, grease trap - sanitary fixtures: washbasins, WCs, bathtubs, urinals, flushing cistern - Types of pipes and joints. Design principles of sanitary layout: location	9

	and ventilation of chambers, traps, fixtures - Building sanitation systems: separate, combined, single stack, one pipe and two pipe - On-site treatment: Septic tanks, Soak pits, Cess pools, dispersion trenches – decentralized treatment systems for multi-storeyed buildings (theory only, no design) - recycling grey water: practices Solid waste quantity, Types and composition, characteristics, on-site processing and disposal methods	
III	**Electrical and Mechanical services** Electrical installations and Accessories of wiring (terminologies and symbols only), Systems of wiring, Electrical layout for residence, small workshop, show room, school building, etc. Air Conditioning: Types of Air Conditioners, (Central type, Window Type, Split Unit), capacity selection of air conditioner Lift: Definition, Types of Lifts, Location, Sizes, Component parts - Elevators & Escalators: Different types of elevators and Escalators, Freight elevators, Passenger elevators, Hospital elevators - Uses of different types of elevators – Escalators – Dumbwaiters: Types and uses - Conveyors: Types and uses. Pumps – Types, Selection, installation, and maintenance	**10**
IV	**Fire and Acoustic management services** Causes and Effects of fire, General Requirements of Fire Resisting building as per IS and NBC 2005, Characteristics of Fire resisting materials, Maximum Travel Distance, Fire Fighting Installations for Horizontal Exit, Roof Exit / Fire Lifts, External Stairs - Firefighting equipment and different methods of fighting fire, means of escape, alarms, etc Requirement of good Acoustic - Factors to be followed for noise control in residential building - Acoustical Materials: Porous materials, panel absorbers, membrane absorbers, acoustical plasters, diffusers, cavity or Helmholtz resonators. Role of functional absorbers, Adjustable acoustics and variable sound absorbers. Acoustical correction and retrofits to existing spaces	**10**
V	**Miscellaneous services** Concept of Green buildings – Sustainable features of Green building – LEED India rating system - energy efficiency, water efficiency – Green materials and equipment - waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture, HVAC Concept of building automation - Design issues related to building automation and its effect on functional efficiency, Components of building automation system; modern security system, alarm system, fire-protection, inter- communication, monitoring devices, mechanical means of vertical and horizontal transportation, Intelligent lighting system etc	**9**

		Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

PROGRAMME ELECTIVE - V

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44A	EARTHQUAKE RESISTANT DESIGN	PEC	3	0	0	3	2020

i) PRE-REQUISTE: ES0U10A MECHANICS OF SOLIDS, CE1U30A STRUCTURAL ANALYSIS I

ii) COURSE OVERVIEW

Goal of this course is to introduce students to the concepts of earthquake resistant design of structures. The course also familiarizes the fundamental theory of structural dynamics based on which seismic design principles are formulated. It also deals with relevant Indian standards for the estimation of seismic forces as well as provisions for ductile detailing.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Model single and multi-degree freedom systems for dynamic analysis and develop equations of motion	Apply
CO 2	Develop the dynamic response of SDOF systems for various dynamic inputs.	Apply
CO 3	Develop the dynamic response of MDOF systems for various dynamic inputs.	Apply
CO 4	Apply the codal provisions for the ductile detailing of buildings.	Apply

iv) SYLLABUS

Overview of structural dynamics: Dynamic analysis, Methods of discretization-single degree of freedom system – undamped free vibration – damped free vibration; Two degree of freedom systems, Lumped mass modelling of MDOF systems - Shear building; Introduction to engineering seismology, Intensity and Magnitude of earthquake, Seismic zones in India, Behaviour of buildings under earthquakes, response reduction factors, Estimation of base shear and its distribution using IS 1893, Ductility considerations in earthquake resistant design of buildings as per IS 13920.

v) (a) TEXT BOOKS

1) Duggal, S. K., Earthquake *resistant Design of Structures*, Oxford University Press, New Delhi, 2013.
2) Paz, M., *Structural Dynamics – Theory and Computations*, CBS Publishers, New Delhi, 2018.
3) Chopra A. K., *Dynamics of Structures*, Pearson Education, New Delhi, 2013.
4) Agarwal P. and Shrikhande M.*, Earthquake Resistant Design of Structures*, PHI Learning Pvt. Ltd., New Delhi 2014.

(b) REFERENCES

1) Paulay T. and Priestley M. J. N., Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons Inc. NewYork, 2011.
2) Clough, R. W. and Penzien, J., *Dynamics of Structures*, McGraw Hill, 2008.
3) IS 1893 (Part I) : 2016 (Reaffirmed 2021), *Indian Standard Criteria for Earthquake Resistant Design of Structures*, Bureau of Indian Standards, New Delhi, 2016.
4) IS 13920 : 2016 (Reaffirmed 2021), *Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – Code of Practice*, Bureau of Indian Standards, New Delhi, 2021.
5) IS 4326 : 2013, *Earthquake Resistant Design and Construction of Buildings - Code of Practice*, Bureau of Indian Standards, New Delhi, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Overview of structural dynamics: Fundamental objective of dynamic analysis- classification of dynamic loads – essential characteristics of a dynamic problem – methods of discretization – lumped mass procedure – generalized displacements – single degree of freedom system – basic components of a dynamic system. Formulation of equation of motion: Newton's 2nd law and D' Alembert's principle; influence of gravitational forces – generalized SDOF systems.	**9**
II	Solution of the equation of motion: undamped free vibration – damped free vibration- critically damped under damped and over damped SDOF systems, Logarithmic decrement. Response to harmonic loading: transient and steady state response of undamped and damped SDOF systems – dynamic amplification factor, force transmissibility and vibration isolation.	**9**
III	Response to periodic loading: Fourier series representation of periodic loads. Response of SDOF systems. Base excited SDOF system: Formulation of equation of motion – Response of SDOF base excited systems; Concept of pseudo acceleration, velocity. Response spectra, Four-way logarithmic plot – DVA spectrum (concept only). Two degree of freedom systems: Formulation of equations of motion – free vibration analysis – frequencies and mode shapes – orthonormalization of modes.	**9**

IV	Lumped mass modelling of MDOF systems: Shear building; free vibration analysis – frequencies and mode shapes; Modal expansion of response, Mode superposition technique (concept only). Introduction to engineering seismology: Plate tectonics – faults – causes of earthquake – energy release – seismic waves - Intensity and Magnitude of earthquake; Measurement of ground motion-Seismographs, Characteristics of ground motion; Seismic zones in India.	**9**
V	Behaviour of buildings under earthquakes: Factors influencing structural performance **–** building configuration, strength, stiffness and ductility; effects of structural irregularities on building performance. Estimation of Seismic Demand: Seismic zones and coefficients; response reduction factors. Estimation of base shear and its distribution along height based on Equivalent static method using IS 1893 for multi storied buildings. Ductility considerations in earthquake resistant design of buildings: Impact and requirements for ductility – factors affecting ductility – ductile detailing considerations in buildings as per IS 13920	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44B	SOIL STRUCTURE INTERACTION	PEC	3	1	0	3	2020

i) **PRE-REQUISITE:** CE1U20E GEOTECHNICAL ENGINEERING I, CE1U30C GEOTECHNICAL ENGINEERING II, CE1U30A STRUCTURAL ANALYSIS I, CE1U30F STRUCTURAL ANALYSIS II

ii) COURSE OVERVIEW

This course introduces the importance of behaviour and analysis of structures while interacting with soil. The actual behaviour of structures with respect to foundation and behaviour of foundation with respect to soil are studied considering different models. This knowledge will be helpful for economising the foundation size and to understand the complex behaviour of soil under particular situation.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the significance of SSI in foundation design, various soil idealizations for SSI and effects of SSI in the design of various foundations	Understand
CO 2	Explain elastic soil behavior related to bearing capacity and settlement	Understand
CO 3	Determination of soil bearing capacity, settlement and contact pressure distribution under the foundation	Apply
CO 4	Apply the mathematical models for 1- Dimensional soil structural analysis	Apply
CO 5	Apply SSI for general engineering design problems	Apply

iv) SYLLABUS

Bearing capacity of soil, settlement for soil, Soil-Structure Interaction, Contact pressure distribution, subgrade modulus, elastic models for soil response, Elastic-Plastic behaviour of soil stratum, Beams on Elastic Foundations, Applications of SSI in engineering design, Dynamic soil structure interaction – Applications.

v) a) TEXT BOOKS

1) Wolf, J.P., Dynamic Soil-Structure Interaction, Prentice-Hall, 1985.
2) Hemsley, J.A., Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
3) Murthy, V.N.S., Advanced Foundation Engineering, CBS Publishers, New Delhi, 1st edition, 2017.
4)

b) REFERENCES

1) Nainan P. Kurian, Design of Foundation Systems, 3rd edition, Alpha Science International Ltd, 2005.
2) Cakmak, A.K., Soil-Structure Interaction, Developments in Geotechnical Engineering 43, Elsevier and Computational Mechanics Publications, 1987.
3) Kramer,S.L., Geotechnical-Earthquake Engineering, 1st edition, Pearson Education, 2003.
4) Hall, W,S., Oliveto Kluwer,O., Boundary Element Method for Soil-Structure Interaction, (2003) edition, Academic Publishers, 2003.
5) Structure Soil Interaction- The real behaviour of Structures, Institution of structural Engineers, London, 1989.
6) Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engineering, 17, Elsevier, 1979.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Soil bearing capacity:** Bearing capacity analysis by Terzaghi's theory, Skempton, Meyorhof and IS code method. Types of settlement for soil – immediate or elastic settlement, primary consolidation settlement, secondary compression settlement. Settlement calculation for granular and clayey soils based on IS code method.	9
II	**Fundamentals of Soil-Structure Interaction:** Introduction to soil-structure interaction– significance of SSI. Contact pressure distribution beneath rigid and flexible footings-cohesive and non-cohesive soils, concept of subgrade modulus-influencing factors, concentrically and eccentrically loaded cases - Static and Dynamic loading effects-static & dynamic SSI (concept only).	9
III	**Elastic models for soil response:** Winkler model, Elastic continuum models – isotropic elastic continuum, layered & structured elastic media, Two parameter elastic models – Filonenko-Borodich, Hetenyi and Pasternak models. Elastic -Plastic behaviour – Time dependent behaviour.	9
IV	**Beams on Elastic Foundations:** Infinite beams resting over Winkler medium – governing differential equation, solutions for the case of infinite beams subjected to concentrated forces and uniform force of finite length. Finite beams resting over Winkler medium- Hetenyi's principle of superposition. Classification of finite beams in relation to their stiffness.	9
V	**Applications of SSI in engineering design:** Soil-structure interactions effects in design of isolated and mat foundations. Soil-structure interaction effects in vertical and lateral pile capacities. Dynamic soil structure interaction – Applications in Low rise residential buildings, multi-storey buildings, bridges, dams, nuclear power plants.	9

	Total hours	45

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44C	AIRPORT, SEAPORT AND HARBOUR ENGINEERING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

Goal of this course is to introduce the fundamental concepts of planning the airports and their design considerations. The course also deals with the planning and design of various features of docks and harbours.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply relevant standards for the site selection and planning of an airport.	Apply
CO 2	Make use of design principles for the design of runway, taxiway, apron and terminal area.	Apply
CO 3	Explain the various aspects of an airport such as markings, lighting and air traffic control techniques.	Understand
CO 4	Explain the various components and features of a harbour and the criteria for site selection and layout of harbours.	Understand
CO 5	Explain the types, operation and repair of docks, and their design considerations.	Understand

iv) SYLLABUS

Introduction to Airport Engineering: components, site selection, classification, and requirements of an ideal airport layout, terminal area.
Runway design, obstructions, approach zone, zoning laws, design of taxiways and aprons.
Marking and lighting of runway approaches, taxiways and aprons, Air traffic control, visual aids and landing information system.
Harbours:classification, features, requirements. Break waters, quays, piers, wharves, jetties, transit sheds and warehouses.
Navigational aids, light houses, signals and communication devices.
Docks: Functions and types - dry docks, wet docks.
Operation of lock gates and passage, Graving docks, Floating docks. Repair of docks.

v) (a) TEXT BOOKS

1) Khanna S K, Arora M G and Jain S S, *Airport Planning and Design*, Nemchand and Brothers, 6th edition, 2017.
2) Srinivasan R, *Harbour, Dock and Tunnel Engineering*, Charotar Publishing House Pvt. Ltd., 30th Edition, 2022.

(b) REFERENCES

1) Horonjeff R, McKelvey F X, Sproule W J and Young S B, *Planning and Design of Airports*, McGraw Hill, 5th edition, 2010.
2) Oza H P and Oza G H, Dock and Harbour Engineering, Charotar Publishing House Pvt. Ltd., 8th edition, 2016.
3) Bindra S P, *A Course in Docks and Harbour Engineering*, Dhanpat Rai and Sons, 2013.
4) Rangwala, *Airport Engineering*, Charotar Publishing House Pvt. Ltd., 17th edition, 2019 (1st reprint).

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Airport Engineering, Components of airport, selection of site for airport. Requirements of an ideal airport layout. Aircrafts and its characteristics, airport classifications as per ICAO. Location and planning of airport as per ICAO and FAA recommendations, airport elements -airfield, terminal area.	10
II	Runway design - Wind rose diagram and orientation of runway, wind coverage and crosswind component, factors affecting runway length, basic runway length, and corrections to runway length. Runway geometrics and runway patterns (configurations). Design of taxiways and aprons, terminal area planning, obstructions, approach zone, zoning laws, airport capacity, airport size.	11
III	Introduction to airport markings, runway marking, lighting of runway approaches, taxiways and aprons. Air traffic control - objectives, control system, control network. Visual aids, landing information system.	8
IV	Harbours – Harbour components, ship characteristics, characteristics of good harbour, and principles of harbour planning. Size of harbour, site selection criteria and layout of harbours, classification, features, requirements. Break waters, quays, piers, wharves, jetties, transit sheds and warehouses - necessity and functions, classification. Navigational aids - light houses, signals - types, channel and entrance demarcation, buoys, beacons, light house communication devices.	8
V	Docks – functions and types - dry docks, wet docks - purpose, design consideration, operation of lock gates and passage, repair docks - graving docks, floating docks and repair of docks.	8
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44D	HYDROCLIMATOLOGY	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U30D HYDROLOGY AND WATER RESOURCES ENGINEERING

ii) COURSE OVERVIEW

The general objective of this course is to give exposure to students on the link between hydrology and climatology through the basic scientific principles and processes will be explored. The students will get an exposure to different hydro-climatological extremes and climate changes. This course also aims to impart the knowledge on modelling the hydrologic impact of climate changes, basic characteristic properties of hydrologic data etc.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the role of meteorological variables on the hydrology of a region	Understand
CO 2	Describe the characteristics of hydrologic extremes and climate change	Understand
CO 3	Apply statistical methods in modelling of hydro-climatic extremes	Apply
CO 4	Describe its procedures for modelling hydrologic impact of climate change	Understand
CO 5	Apply statistical principles in the characterization of hydrologic data	Apply

iv) SYLLABUS

Introduction - weather and climate, hydrometeorology - variables affecting precipitation, cloud – types, Monsoon- characteristics of Indian summer monsoon rainfall.

Atmosphere- vertical structure, Atmosphere- vertical structure, modelling vertical variation and temporal variation of air temperature, heat waves.

Climate variability and extremes, -flood, drought. Frequency analysis of extreme rainfall and flood, Droughts-types, characteristics.

Climate change: Causes and effects of climate change-modelling, Downscaling-concept, IPCC assessment reports, uncertainty in downscaling studies.

Statistical methods in hydro-climatology- principal component analysis, methods for trend analysis, stationary and non-stationary series-.

v) (a) TEXT BOOKS

1) G. S. Campbell, and J. M. Norman, An Introduction to Environmental Biophysics, Springer, 2013.
2) Rajib Maity, Statistical Methods in Hydrology and Hydroclimatology, Springer, 2018.
3) P. Jayarami Reddy, A Text Book of Stochastic Hydrology, Laxmi Publications, New Delhi, 2nd edition, 2016.

4) M. L. Shelton, Hydroclimatology: Perspectives and Applications, Cambridge University Press, 2009.

(b) REFERENCES

1) IPCC, Fourth to Sixth Assessment Reports, 2016.
2) IPCC, Sixth Assessment Reports, 2022.
3) M. Karamouz, S Nasif and M Falahi. Hydrology and Hydroclimatology. CRC press, 2012.
4) KS. Raju, DN Kumar. Impact of Climate change on water resources with modelling techniques and case studies. Springer, 2008.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction - weather and climate; hydrometeorology- variables affecting precipitation- humidity, vapour pressure, saturation vapour pressure–temperature relation (simple problems), perceptible water, forms and types of precipitation; cloud - types; Monsoon- characteristics of Indian summer monsoon rainfall- climate oscillations and Indian monsoon rainfall- El Nino and La Nina.	9
II	Atmosphere- vertical structure; radiation and temperature; the general circulation of atmosphere triple cell model, laws of radiation; temperature variation- modelling vertical variation and temporal variation of air temperature; temperature extremes; diurnal temperature range, heat waves- definition	9
III	Climate variability and extremes: Floods- causes, types, methods of control, flood modelling (brief description only); Frequency analysis of extreme rainfall and flood-problems, Return period Risk and reliability in hydrologic design- simple problems; Droughts-types, characteristics and drought indices	9
IV	Climate change: Causes and effects of climate change, modelling of climate hydrologic impact of climate change on water resources-typical framework, general circulation models and regional climate models; Downscaling-concept and types; IPCC assessment reports, scenarios and database (brief description and salient features only), uncertainty in downscaling studies (brief description only)	9
V	Statistical methods in hydro-climatology: principal component analysis and its use in climate change studies, methods for change point analysis, methods for trend analysis-statistical and graphical methods, stationary and non-stationary series- determination of non-stationarity of hydro-climatic series (no problems)	9
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44E	SUSTAINABLE CONSTRUCTION	PEC	3	0	0	3	2020

i) PRE-REQUISITE: NC0U20A SUSTAINABLE ENGINEERING

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of sustainable building construction. After this course, students will develop awareness on sustainable building materials and construction practices and also exposed to applications of ICT in sustainable construction.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of sustainability	Understand
CO 2	Summarize the properties and uses of sustainable building materials.	Understand
CO 3	Identify suitable construction techniques and practices for sustainable buildings	Apply
CO 4	Explain the standards and guidelines for sustainable buildings	Understand
CO 5	Illustrate the role of BIM and automation in sustainable construction	Understand

iv) SYLLABUS

Introduction to concepts of sustainability: impacts of global warming, sustainability indicators - Carbon foot print, Embodied energy and carbon, sustainability analysis - Life Cycle Analysis, EIA - Concept of Green Buildings

Sustainable building materials: Introduction to sustainable building materials, qualities, use, examples - Natural building materials, locally available and locally manufactured materials – wood, earth, stone and lime based materials.

Contemporary Building Materials. Bio materials: Properties, application, specification and standards (Indian and International). Non Toxic materials: low VOC paints, coating and adhesives. Use of post-consumer and industrial waste such as fly-ash, bags, building construction & demolition waste

Alternative Building Materials - Overview and definition of alternative or appropriate building materials - Geo polymer concrete composites- alternative materials developed and promoted by government organizations and non-government organizations

Sustainable methods & technologies–Eco friendly and low cost techniques - Different substitute for wall construction - Alternate roofing systems - Filler Slab - Composite Beam and Panel Roof – Mivan technique - Contributions of agencies - Cost ford - Nirmithi Kendra – Habitat
Green building rating systems – Guidelines from IGBC – LEED rating system, TERI-GRIHA rating system. **Codes** - Energy Conservation Building Code (BEE), National Building Code. **Green Building Case studies** – Residential, Institutional, and Commercial.
Concept of Net Zero buildings – Use of BIPV and other renewable energy in buildings

ICT for Sustainable Construction: Building Information modeling – Introduction to BIM, concepts and benefits, BIM for construction scheduling, cost estimation and construction management. Building Automation.

v) (a) TEXT BOOKS

1. Sustainable Building - Design Manual Pt 1 & 2, The Energy and Resources Institute, TERI, 2009
2. Ross Spiegel.G, Green Building Materials a Guide to Product Selection and Specification, 3rd Edition, 2010
3. Jagadish, K.S, Alternative Building Materials and Technologies, New age International Pvt Ltd Publishers, 2nd Edition ,2017
4. Traci Rose Rider, Stacy Glass, Jessica McNaughton, Understanding Green Building Materials, W.W. Norton and Company, First Edition, 2011

(b) REFERENCES

1. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors- Chuck Eastman, et al.
2. Automation Systems in Smart and Green Buildings (Modern Building Technology), Er. VK Jain, First Edition, 2009, Khanna Publishers
3. BIS, National Building Code 2005, New Delhi, 2005 Energy Conservation Building Code of India, User manual, 2007
4. Singh. P.K., Rainwater Harvesting: Low cost indigenous and innovative technologies, Macmillan Publishers India, 2008
5. Jagadish. K.S. Building with stabilized mud, I.K. International Publishing House Pvt. Limited 2007

vi) COURSE PLAN

Module	Contents	No. of hours

I	**Introduction to concepts of sustainability:** impacts of global warming, sustainability indicators - Carbon foot print, Embodied energy and carbon, sustainability analysis - Life Cycle Analysis, EIA - Concept of Green Buildings	7
II	**Sustainable building materials:** Introduction to sustainable building materials, qualities, use, examples - Natural building materials, locally available and locally manufactured materials – wood, earth, stone and lime based materials. **Contemporary Building Materials**- concrete, eco block, stabilized blocks (mud blocks, steam cured blocks, Fal-G Blocks stone masonry block.), insulated concrete forms(ISF), hydra form, prefabs / structural insulating panels, cellulose insulation, adobe, rammed earth, earth sheltered and recycled materials - Bio materials : Properties, application, specification and standards(Indian and International) - Bio materials from industrial waste, mining waste, mineral waste, agricultural waste - Nontoxic materials: low VOC paints, coating and adhesives - Use of waste materials such as paper, glass bottles, tires, shipping containers - Use of post-consumer and industrial waste such as fly-ash, bags, building construction &demolition waste – use of salvaged and recycled materials from flooring, columns, beams, timber, glass, etc. **Alternative Building Materials** - Overview and definition of alternative or appropriate building materials - Alternative materials developed and promoted by government organization's like CSIR labs: CBRI and SERC, GRIHA, ASTRA (IISc), BMTPC, HUDCO and its building centres - Alternative materials developed and promoted by non-government organisations DA, Auroville, TERI	10
III	**Sustainable methods & technologies**–Eco friendly and low cost techniques - Different substitute for wall construction - Flemish Bond - Rat Trap Bond – Arches – Panels - Cavity Wall – Ferro Cement and Ferro Concrete constructions – different pre cast members using these materials - Alternate roofing systems - Filler Slab - Composite Beam and Panel Roof -Pre-engineered and ready to use building elements - wood products -steel and plastic –Mivan technique - Contributions of agencies - Cost ford - Nirmithi Kendra – Habitat	10
IV	**Green building rating systems** – Guidelines from IGBC – LEED rating system, TERI-GRIHA rating system. **Codes** - Energy Conservation Building Code (BEE), National Building Code. **Green Building Case studies** – Residential, Institutional, and Commercial. **Concept of Net Zero buildings** – Use of BIPV and other renewable energy in buildings	9
V	**ICT for Sustainable Construction:** Building Information Modeling Introduction to BIM, concepts and benefits, BIM for construction	9

	scheduling, cost estimation and construction management. Building Automation – Concepts, components of BA, applications of BA for functional efficiency of buildings.	
	Total Hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44F	CLIMATE CHANGE AND SUSTAINABILITY	PEC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of climate, its influencing factors, climate change and its relationship with sustainability. After this course, students will be able to recognize the real-world problems that can happen due to climate change, aware of the various mitigation and adaptation techniques using sustainabletechnologies for combating the adverse impacts due to climate change and respond accordingly.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamental concepts of climate and its influencing factors.	Understand
CO 2	Explain the factors affecting climate change and the harmful impacts due to climate change	Understand
CO 3	Identify the problems due to urbanization and the need for sustainable development	Apply
CO 4	Illustrate the various adaptation and mitigation techniques for combating climate change	Understand
CO 5	Identify multilateral agreements on climate change, Case studies on Climate change	Apply

iv) SYLLABUS

Climate: Climate and weather, Meteorology and climatology, Composition and structure of atmosphere. Factors influencing climate, Inversions, Types of inversions. Cyclones and Anticyclones

Climate change: Climate change, anthropogenic drivers of climate change, Global warming, Greenhouse effect, Air pollution, carbon footprint, Impact of climate change, Carbon sequestration, Vulnerability index

Urbanisation and Sustainable development: Urbanisation and Industrialization, problems of urbanisation. Urban flooding, water conservation and ecological aspects. Urban Planning, Zoning of Land Use

Pillars of Sustainable development, Sustainability indicators, Life cycle analysis, Material flow analysis, Green energy, Waste management, 3R concepts, Sustainable cities.

Adaptation and mitigation strategies: Green Engineering, Design for Engineering, Green technologies, Circular economy. Planning of cities as climate resilient. Climate resilient infrastructure, nature based solutions in disaster management, adaptation strategies for combating climate change

Climate and Sustainability: Sustainability Engineering, Kyoto mechanisms to reduce GHG emission- Clean Development Mechanism, Joint Implementation, Emission trading, Case studies on Kyoto mechanism, Case studies on climate change and climate change risk reduction.

V) (a) TEXT BOOKS

1) Lal, D.S., *Climatology,* Sharda Pustak Bhawan Publishers, 2021
2) Tomkin, J., Theis, T., *Sustainability - A Comprehensive Foundation*, 12th Media Services, 2018
3) Hardy, J.T., Ponce, J., *Climate Change - Causes, Effects, and Solutions*, Wiley Publications, 2003

(b) REFERENCES

1) Intergovernmental Panel on Climate Change (IPCC) reports,2022

2) Baojie H, Sharifi A, Feng C Yang J , Climate Change and Environmental Sustainability- Volume2,MDPI AG,2022
3) Leal Filho, W., Azul, A.M., Brandli, L., Özuyar, P.G., Wall, T. (Eds.), *Sustainable Cities and Communities*, Springer,2020
4) Karuppu, K., *Green Building Guidance: The Ultimate Guide for IGBC Accredited Professional Examination Book*, NVICO Notion Press, 2019
5) Alverson, K.D., ZintaZommers, *Resilience : The science of adaptation to climate change, Elsevier, 2018*
6) Mishra R.K Janaki Krishna P.S, Ch.Lakshmi Kumar , Climate Change and Sustainable Development -Global Perspective,Academic Foundation,2018

VI) COURSE PLAN

Module	Contents	No. of hours
I	Climate and weather, Meteorology and climatology, Composition and structure of atmosphere. Factors influencing climate-Insolation, Temperature, Humidity, Pressure, Wind, Precipitation, Topography. Atmospheric stability, Lapse rate, Inversions, Types of inversions. Cyclones and Anticyclones	9
II	Climate change, anthropogenic drivers of climate change, Global warming, Greenhouse effect, Air pollution, carbon foot print, Impact of climate change on water cycle, agriculture, forest, water resources, urban areas, biodiversity, human health. Carbon sequestration, vulnerability index.	9

III	Urbanisation and Industrialization, Urbanisation, problems of urbanisation, Urban sprawl, Urban heat islands, causes, mitigation measures. Urban flooding, water conservation and ecological aspects. Urban Planning, Zoning of Land Use, Pillars of Sustainable development, Sustainability indicators, Life cycle analysis, Materialflow analysis, Green energy, Waste management, 3R concepts, Sustainable cities, Sustainable Urbanisation	**9**
IV	Green Engineering, Design for Engineering, Green technologies, Circular economy. Planning of cities as climate resilient, Climate change and infrastructure planning, Climate resilient infrastructure, nature based solutions in disaster management, adaptation strategies for combating climate change	**9**
V	Sustainability Engineering , Kyoto mechanisms to reduce GHG emission- Clean Development Mechanism, Joint Implementation, Emission trading, Case studies on Kyoto mechanism, Case studies on climate change and climate change risk reduction	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44G	BUILDING INFORMATION MODELLING	PEC	3	0	0	3	2020

i) PRE-REQUISITE: CE1U38D CIVIL ENGINEERING SOFTWARE LAB

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the use of Building Information Modelling in building construction projects. Students will learn terminology associated with buildings, the theory and evolution of BIM, and how to develop BIM models using software like Autodesk Revit.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the concept and advantages of BIM.	Understand
CO 2	Apply the various processes on a BIM model.	Apply
CO 3	Appraise the collaborative and interoperability capabilities of BIM.	Apply
CO 4	Explain BIM execution plan.	Understand
CO 5	Apply the principles of integrated project delivery.	Apply

iv) SYLLABUS

Introduction to BIM- Object-Based Parametric Modeling BIM Model Quality and Model Checking, BIM software training- Create Modeling Views- Analyse the design- Schedules- Rendering- Walkthroughs, Collaboration, Interoperability and roles- BIM for stakeholders- BIM Adoption- Maturity Levels- BIM Guides, BIM Execution Plan - Overview- Implementing the BIM Project Execution Planning Procedure, Integrated Project Delivery- Principles, Mutual Respect and Trust, Mutual Benefit and Reward, Defining and Measuring Project Outcomes Delivering an Integrated Project.

v) a) TEXT/ REFERENCE BOOKS

1) Borrmann A., Konig M., Koch C. and Beets J., Building Information Modeling: Technology Foundations and Industry Practice, Springer, 2018.
2) Kymmell W., Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations, McGrawHill Construction.
3) Eastman C., Teicholz P., Sacks R. and Liston K., BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons, 2008.

4) Messner J., Anumba C., Dubler C., Goodman S., Kasprzak C., Kreider R., Leicht R., Saluja C., Zikic N., and Bhawani S., BIM Project Execution Planning Guide, Version 3.0.
5) Integrated Project Delivery: A Guide by American Institute of Architects.
6) Autodesk Revit: User Guide by Autodesk

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to BIM Traditional AEC Business Model and its inefficiencies What is BIM? – BIM vs 3D vs 2D – BIM as a product vs BIM as a process BIM as a lifecycle platform Why BIM – incentives and benefits – technical and financial. The Evolution to Object-Based Parametric Modeling BIM Model Quality and Model Checking	**9**
II	BIM software training Create Modeling Views - Model Layout - Architectural Modeling-Structural Modeling-MEP Modeling-Construction Modeling - Project Management - Revit Families - Tools and Techniques - Project Phasing - Document and Present the Design -Analyze the Design (Energy, solar, area, etc.) – Schedules - Rendering – Walkthroughs (Topics have to be discussed and demonstrated with the help of software at the Laboratory; Each topic will be an assignment in each week. Theory classes may progress with the other modules.)	**9**
III	Collaboration, Interoperability and roles BIM for stakeholders - Owners, Facility Managers and Government Institutions, Architects and Engineers, Contractors, Subcontractors and Fabricators. BIM Adoption, Maturity Levels BIM Guides (From countries like Finland, Denmark, Belgium etc) Data Exchange Methods – File based, Cloud based and local data exchange methods Product Data Models and Standardization File-Based Exchange and BIM Servers, IFC – Industry Foundation classes, COBie	**9**
IV	BIM Execution Plan Overview of the BIM Execution Planning Procedure for Building Information Modeling - Establish Project Modeling Goals Select Model Uses - Design the BIM Process - Define the Information Exchanges Plan Infrastructure - Implementing the BIM Project Execution Planning Procedure - BIM Project Execution Planning for Organizations - Conclusions and Recommendations	**9**
V	Integrated Project Delivery Principles of Integrated Project Delivery - Mutual Respect and Trust, Mutual Benefit and Reward, Collaborative Innovation and Decision Making, Early Involvement of Key Participants, Early Goal Definition,	**9**

	Intensified Planning, Open Communication, Appropriate Technology, Organization and Leadership Setting Up an Integrated Project - IPD Team Building and Functioning, Defining Roles, Responsibilities and Scopes of Services, Defining and Measuring Project Outcomes Delivering an Integrated Project- Building an Integrated Team, Project Execution / Redefining Project Phases	
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U44H	GEOTECHNICAL EARTHQUAKE ENGINEERING	PEC	3	0	0	3	2020

I) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING - I

ii) COURSE OVERVIEW

After the completion of course, students will learn about all the engineering aspects of earthquakes and ground response and they would be able to analyse and quantify earthquake hazard in terms of ground amplifications, deformations and liquefaction.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the behaviour of ground during the earthquakes	Understand
CO 2	Explain engineering aspects of earthquakes, ground response and fundamental principles of wave propagation	Understand
CO 3	Determine various dynamic properties of soils	Apply
CO 4	Outline the concepts of liquefaction and mitigation measures	Understand
CO 5	Explain mitigation measures of earthquake hazards	Analyze

iv) SYLLABUS

Introduction to earthquake hazards, Overview of plate tectonics and earthquake source mechanisms, Theory of Wave propagation, Dynamic Soil Properties, Concepts of Seismic magnitudes and intensity, Interpretation of seismic records, Regional seismicity and earthquakes in India, Seismic hazard analysis, Site characterization, Liquefaction.

v) (a) TEXT BOOKS

1) Kramer, S. L., Geotechnical Earthquake Engineering, Pearson Education,1stEdition,2003.
2) Reiter, L., Earthquake Hazard Analysis- Issues and Insights, Columbia University Press, New York, 1ST Edition 1990

3) Bozorgnia, Y. and Bertero, V.V., Earthquake Engineering- From Engineering Seismology to Performance based Engineering, CRC Press Washington, 2004.
4) Day, R. W., Geotechnical Earthquake Engineering Hand Book, McGraw- Hill, 2nd Edition, 2012.

(b) REFERENCES

1) Towhata, I., Geotechnical Earthquake Engineering , Springer- Verlag Heidelberg, 2010.
2) Srbulov, M., Geotechnical Earthquake Engineering: Simplified Analysis with Case Studies and Examples, Springer- Verlag, 2008.
3) IS 1893: 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures, New Delhi, 2002.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Geotechnical Earthquake Engineering, Engineering Seismology & Plate Tectonics, Types of Faults and Plate Boundaries, Seismic waves, Earthquake Hazards, Size of Earthquakes.	**9**
II	Strong Ground Motion, Ground Motion parameters, Estimation of Ground Motion Parameters, Seismic Hazard Analysis, Concepts of Deterministic Seismic Hazard Analysis, Concepts of Probabilistic Seismic Hazard Analysis.	**9**
III	Wave propagation, Dynamic Soil Properties, Evaluation of Dynamic Soil Properties by Field tests, Evaluation of Dynamic Soil Properties by Laboratory tests, Stress- Strain behaviour of cyclically loaded soils.	**9**
IV	Introduction to Liquefaction, Concepts of Liquefaction, Initiation of liquefaction, Evaluation of Liquefaction, Liquefaction Hazards, Post liquefaction strength of soils.	**9**
V	Ground Response Analysis, Soil- structure interaction, Local site effects, Mitigation of effects of earthquake, Ground improvement for mitigating earthquake hazards, Numerical modelling in earthquake geotechnical engineering.	**9**
	Total hours	**45**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U40C	COMPREHENSIVE VIVA VOCE	PCC	1	0	0	1	2020

i) COURSE OVERVIEW

Goal of this course is to ensure that the students know the basics of all the core subjects in the curriculum. The viva voce shall be conducted based on the core subjects studied from third semester to eighth semester. This course helps the student be competent in placement tests and other competitive exams.

ii) GUIDELINES

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project Coordinator, expert from Industry/ research institute and a senior faculty from a sister department
3. The minimum pass mark for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other course.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

iii) MARK DISTRIBUTION

Total Marks: 50

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1U49C	PROJECT PHASE II	PWS	0	0	6	6	2020

i) PREREQUISITE: NIL

ii) COURSE OVERVIEW:

The course ‘Project Work’ is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8thsemester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Model and solve real world problems by applying knowledge across domains.	Apply
CO 2	Develop products, processes or technologies for sustainable and socially relevant applications.	Apply
CO 3	Organize effectively as an individual as well as a leader in diverse teams and to comprehend and execute designated tasks.	Apply
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.	Apply
CO 5	Examine technology/research gaps and propose innovative/creative solutions.	Analyze
CO 6	Organize and communicate technical and scientific findings effectively in written and oral forms	Apply

iv) SYLLABUS

Project Phase II

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as

needed.

- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster leveland/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the DepartmentAssessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for eachevaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined **(5)**

Literature survey: Outstanding investigation in all aspects. **(4)**

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. **(7)**

Individual Contribution: The contribution of each student at various stages. **(7)**

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. **(5)**

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope[CO5] [Group Evaluation]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the workdone so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence forthe originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	5	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.

			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to projectschedule. [CO4] [Group Evaluation]	5	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use inthe project. The students do not have any idea on the budget required even after the end ofphase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the projectguide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-d	Interim Results. [CO6] [Group assessment]	5	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	5	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

Phase-II Interim Evaluation - 1 Total Marks: 25

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	10	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of applicationof engineering knowledge in the design and development ofthe project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement ofindividual members [CO3] [Individual Assessment]	5	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but islimited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	5	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.

			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation andpresentation. .[CO6] [Individual assessment]	5	The individual student has no idea onthe presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop anexcellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and /orindustrial needs. [Group Assessment][CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification andmanaged to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty /Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.

					learning and engineering ingenuity. Could be translated into a product / process if more work is done.	
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-n	Presentation - Part I Preparation of slides.[CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However,its organization is not very good.Language needs to be improved. Allreferences are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is roomfor improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - PartII: Individual Communication [CO6] [Individual Assessment	5	The student is not communicatingproperly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication bythe student. The student is able toexplain most of the content very well. There are however, a few areas wherethe student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all thequestions without hesitation. Exceptional traits of communicator.

	].			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40							

MINORS IN CIVIL ENGINEERING

Semester	BASKET I				BASKET II				BASKET III				BASKET IV			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S3	CEOM 20A	Building Construction and Structural Systems	4-0-0	4	CEOM20B	Introduction to Geotechnical Engineering	4-0-0	4	CEOM20C	Informatics for Infrastructure Management	3-1-0	4	CEOM 20D	Building Technology and Interior Designing	3-1-0	4
S4	CEOM 20E	Building Drawing	2-2-0	4	CEOM20F	Introduction to Transportation Engineering	3-1-0	4	CEOM20G	Climate Change and Hazard Mitigation	4-0-0	4	CEOM 20H	Building Drawing and Estimation	4-0-0	4
S5	CEOM 30A	Structural Mechanics	4-0-0	4	CEOM30B	Eco-Friendly Transportation Systems	3-1-0	4	CEOM30C	Sustainability Analysis and Design	4-0-0	4	CEOM 30D	Sensing and Data Mining for Smart Structures and Systems	4-0-0	4
S6	CEOM 30E	Estimation and Costing	4-0-0	4	CEOM30F	Geotechnical Investigation and Ground Improvement Techniques	4-0-0	4	CEOM30G	Environmental Health and Safety	4-0-0	4	CEOM 30H	Construction Quality Management	4-0-0	4
S7	CEOM 49A	Mini Project	0-1-6	4	CEOM49A	Mini Project	0-1-6	4	CEOM49A	Mini Project	0-1-6	4	CEOM 49A	Mini Project	0-1-6	4
S8	CEOM 49B	Mini Project	0-1-6	4	CEOM49B	Mini Project	0-1-6	4	CEOM49B	Mini Project	0-1-6	4	CEOM 49B	Mini Project	0-1-6	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20A	BUILDING CONSTRUCTION AND STRUCTURAL SYSTEMS	MINOR	4	0	0	4	2020

i) COURSE OVERVIEW

The course provides the essential aspects of building construction such as components of buildings, materials of construction and structural systems to the students of other branches of Engineering.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the properties of different materials used for building construction.	Understand
CO 2	Explain the testing methods of different materials used for building construction.	Understand
CO 3	Explain the construction details of different components of buildings.	Understand
CO 4	Explain construction practices such as prefabricated, cost effective and sustainable technologies.	Understand
CO 5	Interpret the behaviour of structural systems and structural elements used in buildings.	Apply

iii) SYLLABUS

Cement – Types, Composition, manufacturing process, properties, tests. Aggregates – properties, tests. Mortar – types, properties, uses. Chemical admixtures – types, uses.

Concrete – PCC, RCC. Properties of fresh concrete, Workability – tests. Properties of hardened concrete – tests for strength, Nominal mix and design mix.

Flooring and roofing materials, Lintels and arches, Types and construction details of doors, windows and ventilators. Finishing works, Timber products, Formwork

Foundations – shallow and deep, Cost effective construction, Sustainable building technologies, Non-destructive testing of concrete, Prefabricated construction

Structural elements - beams, columns and slabs. Principles of reinforced concrete, types of reinforcements, Reinforcement details of structural elements, Structural systems, Concrete floor systems.

iv) (a) TEXT BOOKS

1) Punmia, B. C., *Building Construction*, Laxmi Publications, 11^{th} Edition, 2016.

2) Arora, S. P. and Bindra, S. P., *Building Construction*, Dhanpat Rai Publications, 2010.

3) Neville, A. M. and Brooks, J. J., Concrete Technology, Pearson Education, 2nd Edition, 2010.

(b) REFERENCES

4) Mehta, M., Scarborough, W. and Armpriest, D., *Building Construction – Principles, Materials and Systems*, Pearson Education, 3rd Edition 2018.

5) Shetty, M. S., and Jain, A. K., Concrete Technology, S Chand Publications, 8th Edition, 2019.

6) Schodek, D. and Bechthold, M., *Structures*, Pearson Education, 7th Edition, 2014.

7) Varghese, P. C., Building Materials, PHI Learning Pvt Ltd., 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Cement – Types of cements, chemical composition. Blended cements Manufacturing of cement, Properties and tests on cement, Hydration of cement, Aggregates – types, role of aggregates. Properties of aggregates and tests. Grading requirements. Natural and synthetic aggregates. Mortar – types, Sand – properties, uses. Water quality for construction. Chemical admixtures – types and uses.	11
II	Concrete – PCC, RCC and Prestressed concrete (brief descriptions only). Making of concrete – batching, mixing, transporting, placing, compacting, finishing and curing. Properties of fresh concrete – workability, segregation and bleeding. Factors affecting workability and strength – tests on workability, demonstration of slump test. Effects of aggregates on properties of concrete. Properties of hardened concrete – tests for strength of concrete in compression, tension and flexure. Nominal mixes and design mixes, mix designations, ready mixed concrete	13
III	Flooring and roofing materials, Lintels and arches – types. Doors, Windows and ventilators – types and construction details, Finishing works. Paint – types, Timber – seasoning, Timber products – properties and uses of plywood, fibre board and particle board, Formwork, Construction and expansion joints	13
IV	Types of shallow foundations. Types of deep foundations. Foundation failure – causes. Introduction to cost effective construction – principles of filler slab and rat-trap bond masonry. Sustainable building technologies. Non-destructive testing of concrete – rebound hammer	11

	test and ultrasonic pulse velocity test (with demonstrations). Introduction to prefabricated construction- advantages, slip form construction.	
V	Introduction to structural systems – functions, Primary structural elements – beams, columns and slabs. Principles of reinforced concrete, types of reinforcements – tension reinforcements, compression reinforcements and stirrups. Reinforcement details of beams, columns and slabs. Structural systems – load bearing walls, moment resisting frames Structural systems – trusses, cables and membranes. Elevated concrete floor systems, beams supported concrete floors – one way and two-way slabs, flat slabs	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20B	INTRODUCTION TO GEOTECHNICAL ENGINEERING	Minor	4	0	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of soil mechanics and foundation engineering. After this course, students will be able to identify and classify the soil and to recognize practical problems in real-world situations and respond accordingly.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basic concepts, theories and methods of analysis in soil mechanics and foundation engineering.	Understand
CO 2	Solve the basic properties of soil by applying functional relationships.	Understand
CO 3	Determine the engineering properties of soil by applying the laboratory test results and the fundamental concepts.	Apply
CO 4	Estimate the design parameters of footings and retaining walls.	Apply
CO 5	Explain the behaviour of soil deformation and predict the rate of settlement of foundations.	Apply

iii) SYLLABUS

Introduction to soil mechanics - Major soil deposits of India. Basic soil properties - Relationship between basic soil properties. Laboratory Determination of Water content by oven drying.

Soil Structure: single grained, honey combed, flocculated and dispersed structure and their effects on the basic soil properties – Sensitivity and Thixotropy. Index properties - Sieve analysis. Consistency - Atterberg Limits and Plasticity Index – Plasticity Chart –I.S. classification.

Permeability of soils - Darcy's law. Principle of effective stress - Total, neutral and effective stress – Pressure diagrams. Stress distribution - Boussinesq's equations for vertical pressure due to point loads –Isobars- Pressure bulbs.

Shear strength of soils- Mohr-Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses–Brief discussion of Direct shear test & UCC.

Lateral earth pressure –Rankine's theories Influence of surcharge, layered backfill and water table on earth pressure.

Foundation - General consideration: Functions of foundations - Definition of shallow and deep foundations - Different types of foundations: Selection of type of foundation - Advantages and limitations of various types of foundations.

Bearing capacity of shallow foundations –Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip– Bearing capacity factors and charts - Terzaghi's formulae for circular and square footings Local and general shear failure - Effect of water table on bearing capacity.

Settlement analysis: Introduction - causes of settlement -Estimation of immediate settlement.

Consolidation - Definition – Spring analogy for primary consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Pre consolidation Pressure - Compression Index-Estimation of magnitude of settlement of normally consolidated clays.

Compaction of soils - Difference between consolidation and compaction - IS Light & Heavy Compaction Tests – OMC and MDD.

iv) (a) TEXT BOOKS

1. Ranjan, G., and Rao, A.S.R., *Basic and Applied Soil Mechanics,* New Age International (P) Limited, New Delhi, 3rd edition, 2016.
2. Venkataramaiah, *Geotechnical Engineering*, Universities Press (India) Limited, Hyderabad, 6th edition, 2018.
3. Terzaghi, K., *Theoretical Soil Mechanics*, John Wiley & Sons, 1943.

(b) REFERENCES

4. Bowles, J. E., Physical and Geotechnical Properties of Soils, McGraw-Hill Book Company, 2nd edition,1989.
5. Das, B. M., Principles of Geotechnical Engineering, Cengage Learning Inc, 7th Edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to soil mechanics - Soil types -Major soil deposits of India - 3 phase system - Basic soil properties: Void ratio, porosity, degree of saturation, air content, water content, specific gravity, unit weight - Relationship between basic soil properties - numerical problems. Laboratory Determination of Water content by oven drying; Specific gravity using pycnometer & specific gravity bottle and Field density by sand replacement method – Field density by Core Cutter method - Soil Structure: single grained, honey combed, flocculated and dispersed structure and their effects on the basic soil properties – Sensitivity and Thixotropy.	12
II	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils - Consistency - Atterberg Limits and Plasticity Index – Plasticity Chart –I.S. classification. Permeability of soils - Darcy's law – Numerical Problems - Factors affecting permeability Principle of effective stress - Total, neutral and effective stress – Pressure diagrams - numerical problems Stress distribution - Boussinesq's equations for vertical pressure due to point loads – Approximate methods for Vertical Pressure beneath rectangular shape: 2:1 Distribution Method - numerical problems -Isobars- Pressure bulbs	12

III	Shear strength of soils- Practical Applications - Mohr-Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses– relationship between shear parameters and principal stresses [no derivation required] – Numerical Problems - Brief discussion of Direct shear test & UCC Lateral earth pressure – At-rest, active and passive earth pressures – Rankine's theories [no derivation required] - Influence of surcharge, layered backfill and water table on earth pressure-numerical problems .	**12**
IV	Foundation - general consideration: Functions of foundations - Definition of shallow and deep foundations - Different types of foundations: Strip Footings; Isolated Footings; Combined Footings – Rectangular and Trapezoidal; Raft Foundations and Pile Foundations - Selection of type of foundation - Advantages and limitations of various types of foundations Bearing capacity of shallow foundations – Ultimate, safe and allowable bearing capacity. - Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip footing [no derivation required] – Bearing capacity factors and charts - Terzaghi's formulae for circular and square footings - numerical problems - Local and general shear failure - Factors affecting bearing capacity – Effect of water table on bearing capacity - numerical problems .	**12**
V	Settlement analysis: Introduction - causes of settlement – immediate, consolidation and total settlement –Estimation of immediate settlement – Numerical Problems – Consolidation - Definition – Spring analogy for primary consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Pre consolidation Pressure - Compression index-Estimation of magnitude of settlement of normally consolidated clays - Numerical problems Allowable settlement - Total and differential settlements as per Indian standard Compaction of soils - Difference between consolidation and compaction - IS Light & Heavy Compaction Tests – OMC and MDD.	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20C	INFORMATICS FOR INFRASTRUCTURE MANAGEMENT	MINOR	3	1	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to introduce the students to the scope of Informatics and Internet of Things (IoT) in Civil Engineering. It develops the fundamentals of data analytics necessary for informatics and IoT to be applied to various fields of Civil Engineering. After this course, students will be able to use Informatics and IoT for infrastructure management.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the concepts of data to information and how the data is to be processed.	Understand
CO 2	Discuss the use of geomatics in planning and site selection ofinfrastructure projects.	Understand
CO 3	Classify appropriate building informatics for its use in various fields of Civil Engineering.	Understand
CO 4	Interpret, the scope of Building Information Modelling and its applications in several case studies.	Apply
CO 5	Utilise IoT for infrastructure Management in various fields of Civil Engineering.	Understand

iii) SYLLABUS

Data to Information: History of informatics, data pyramid, data management, data types, database; Data analysis techniques, trends and patterns; Data mining techniques, data processing for information.

Geo-informatics: Fundamental concepts in Geo-informatics, Methods of data input, Spatial data editing; data analysis, local operations, neighbourhood operations, zonal operations; GIS output.

Planning and Site selection**:** Site suitability analysis, Solid Waste Disposal, Water treatment plant, reservoirs; Land use/ Land cover mapping, Ground Water Potential Zonation Mapping, Hazard ZonationMapping, Network Analysis.

Building Informatics**:** Modelling, Definition, Elements, steps and application in BIM, Case studies related to BIM.

Internet of Things (IoT) in Civil Infrastructure:IoT Standards and Protocols, Concept, Applications,product monitoring and project Management. Smart Buildings- sensors & devices, Management Applications, Water Supply, Pollution control.

iv) (a) TEXTBOOKS

1) J. Campbell, *Essentials of Geographic Information Systems*, Saylor Foundation, 2011.
2) BIM Handbook*, A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*, John Wiley & Sons; 3rd Edition 2018.
3) Ramez, E., Shamkant, B, N., *Fundamental of Database Systems*, Pearson Addison Wesley, 2003.

(b) REFERENCES

4) Raja, R.A.I., and Svetlana, O., *Building Information Modeling: Applications and Practices*, ASCE, 2015.
5) Samuel, G., *The Internet of Things*, The MIT Press Essential Knowledge Series, 2015
6) Shashi, S., and Sanjay, C.,*Spatial Databases: A Tour*, Prentice Hall, 2003.
7) *Building Information Modeling: BIM in Current and Future Practice*, JohnWiley & Sons; 1st Edition, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Data to Information**: History of informatics, data pyramid - DIKW model, data management- data types, Meta data, database management systems; Data analysis techniques-spatial and non-spatial data, trends and patterns; Data mining techniques, data processing for information.	12
II	**Geo-informatics**: Fundamental concepts in Geo-informatics-Components, Spatial data and attributes, vectorand raster data models, Methods of data input, Spatial data editing; Vector data analysisbuffering,overlay; Raster data analysis- local operations, neighbourhood operations, zonal operations; GIS output: cartographic and non-cartographic output.	12
III	**Planning and Site selection:** Site suitability analysis - Residential area, Industrial area, Recreational Area, Solid Waste Disposal, Water treatment plant, reservoirs; Land use/ Land cover mapping, Ground Water Potential Zonation Mapping, Hazard ZonationMapping, Terrain modelling Network Analysis- Water supply line, Sewer line, Power line, Telecommunication, Roadnetwork.	12
IV	**Building Informatics:** Building Information Modelling- Definition, Elements of BIM, steps in BIM development, applications of BIM, Case studies related to BIM.	12
V	**Internet of Things (IoT) in Civil Infrastructure:** IoT Standards and Protocols, Concept of IoT in Civil Engineering-Applications in construction,product monitoring and project Management. Smart Buildings- sensors & devices, selection criteria, data integration ,Management Applications- Water Supply, Pollution control.	12
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20D	BUILDING TECHNOLOGY AND INTERIOR DESIGNING	MINOR	3	1	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

The goal of this course is to expose the student to building material and understand its properties and application. It provides the understanding about pre – fabricated construction and different building components, construction and services. It also covers computer aided drawing.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain different building materials and their application.	Understand
CO 2	Classify different building components.	Understand
CO 3	Explain pre-fabricated construction.	Understand
CO 4	Explain the fundamentals of Interior Design	Understand
CO 5	Comprehend the relationship between different elements of interior architecture	Understand
CO6	Apply the principles of Interior for costing of Interior projects based on drawings and specification sheets	Apply

iv) SYLLABUS

Introduction, Classification, properties and application of building material, Different building components, Types of building, Components of building & its functions, Types of building services, Prefabricated construction, Concept of plan of a simple residential building, Principles of planning, Building rules, Design process and role of CAD, Application of CAD in building drawing.

v) (a) TEXT BOOKS

1) Allen, E. and Iano, J., *Fundamentals of Building Construction: Materials and Methods*, John Wiley & Sons, 7th Edition, 2019.

2) Bhavikatti, S. S. and Chitawadagi, M. V., *Building Planning and Drawing*, I.K. International Publishing House Pvt. Ltd, 2014.

3) Mamlouk, M. S. and Zaniewski, J. P., *Materials for Civil and Construction Engineering*, Pearson Publishers, 2013.

4) Mckay, W.B. and Mckay, J. K., *Building Construction*, Volumes 1 to 4, Pearson India Education Services, 2015.

(b) OTHER REFERENCES

5) Chen, W.F. and Liew, J. Y. R. (Eds), *The Civil Engineering Handbook*, II Edition, CRC Press (Taylor and Francis), 2002.

6) Chudley, R. and Greeno, R., *Building Construction Handbook*, Addison Wesley, Longman group, England, 2016.

7) Chudley, R., *Construction Technology*, Volume I to IV, Pearson Prentice Hall, 2005.

8) *Kerala Municipality/ Panchayath Building Rules*, Kerala Government, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Classification, properties and application of building material: Building Stones, Lime, Bricks, Cement, Aggregates, Ceramic Building Material, Timber, Mortar, Pozzolans, Concrete, Geo-synthetic material, Admixtures, Special concrete, Ferrous and Non Ferrous metal, Bitumen, tar, asphalt, Miscellaneous materials.	**12**
II	Doors and Windows: Doors: Location, technical terms, size, types, construction and suitability. Windows: Factors affecting selection of size, shape, location and no. of windows, types, construction, suitability, fixtures and fastenings. Ventilators: Ventilators combined with window, fan light. Stairs and Staircases: Definition, technical terms, requirements of good stair, fixing of going and rise of a step, types of steps, classification, example – stair planning, elevators, escalators.	**12**
III	Prefabricated construction: Advantages, foundation units, wall panels, frames for opening, walls–units for roofs and floors – low cost roof systems. Ferro cement – use and application – modular co-ordination – method of production – flow line method – station method – manufacturing process for structural units	**12**
IV	Introduction to Interior Architectural Design- Definition of interior design, Interior architectural design process, vocabulary of design in terms of principles and elements. Elements of Interior Architecture - Space programming study of the relationship between furniture and spaces, human movements & furniture design as related to human comfort. Study on furniture for specific types of buildings. Design Projects on Residential, Commercial and Office Interiors.	**12**

V	Quantification and costing in Interior Design: Overall costing of Interior projects based on drawings and specification sheets - Wall and floor coverings – paints, wallpaper, carpets/rugs. Quantification and costing of material required for furniture like sofa, cushions etc - Accessories & Hardware –Functional & decorative accessories, ironmongery - equipments required in specific areas like kitchen.	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20E	BUILDING DRAWING	MINOR	2	2	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to expose the students to building rules, impart training in visualisation and planning of various types of buildings and their components.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Prepare the engineering drawings of different types of buildings and their components using AutoCAD.	Apply
CO 2	Prepare the site plan and service plan as per the latest building rules.	Apply
CO 3	Prepare the detailed drawings of septic tank and soak pit.	Apply

iii) SYLLABUS

General – Study of IS Codes of practice on building drawing – Scales- method of dimensioning.

Sectional plan and elevation, front view and joint details of Panelled door and Glazed windows.

Types of Roof- Roofing- Elevation and joint details-Roof truss in steel sections.

Types of Stairs- Plan and sectional elevation of reinforced concrete staircase.

Building rules- Two storied and multi-storeyed building- Plan, section and elevation. Public buildings like offices, bank, dispensary etc.

Building rules -Industrial building- Plan, section and elevation.

Preparation of site plan and service plan.

Preparation of Septic tank and soak pit -detailed drawing.

iv) (a) TEXT BOOKS

1) Dr. Balagopal, T. S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut, 1987.
2) Shah, M.G., Kale, C. M. and Patki, S. Y. Building Drawing With An Intergrated Approach to Built Environment, Tata McGraw Hill Publishing Company Limited, New Delhi, 2002.

(b) REFERENCES

3) National Building Code of India, 2016.

4) Kerala Municipal Building Rules, 2019.

5) AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA

v) COURSE PLAN

Module	Contents	No. of hours
I	General – Study of IS Codes of practice on building drawing – Scales-method of dimensioning. Sectional plan, sectional elevation, front view and joint details of Panelled door and Glazed windows.	**12**
II	Types of Roof- Roofing- Elevation and joint details-Roof truss in steel sections. Types of Stairs- Plan and sectional elevation of reinforced concrete staircase.	**12**
III	Building rules- Two storied and multi-storeyed building- Plan, section and elevation. Public buildings like offices, bank, dispensary etc.	**15**
IV	Building rules and types of Industrial building, Plan, section and elevation of industrial building. Preparation of site plan and service plan.	**15**
V	Preparation of detailed drawing - Septic tank and soak pit.	**6**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20F	INTRODUCTION TO TRANSPORTATION ENGINEERING	Minor	3	1	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to introduce the principles and practice of Highway, Traffic Engineering and Transportation Planning.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basics of highway geometric design.	Understand
CO 2	Apply standard procedures to determine the characteristics of pavement materials.	Apply
CO 3	Explain traffic engineering characteristics and road traffic control methods.	Understand
CO 4	Explain the various features of railways, airways, docks and harbour.	Understand
CO 5	Explain the different methods of construction of flexible and rigid pavements.	Understand

iii) SYLLABUS

Introduction to Transportation Engineering, Role of transportation in the development of a society, Classification of roads, Typical cross sections of roads in urban and rural area.

Introduction to geometric design of highways, highway cross section elements. Introduction of flexible and rigid pavements. Introduction to highway materials, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil.

Construction of bituminous pavements and rigid pavements (Basics only).

Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service, Design Speed, Traffic signals and markings, Types of road intersections, Traffic control devices (Introduction only).

Railway Engineering - Component parts of a railway track - functions, concept of Gauges, coning of wheels.

Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only).

Airport Engineering - Components of airport and airport layout, Runway orientation, Taxiways, aprons and Terminal Building (Introduction only).

Transportation Planning - Need for Transportation planning, Transport- land use interaction, Travel Demand Estimation – (Introduction only)

Sustainable urban transport; issues and challenges, Emerging concepts in sustainable transportation: green vehicles and green roads, green and alternate fuels.

iv) (a) TEXT BOOKS

1) Khanna, S. K., Justo, E. G. and A Veeraragavan, Highway Engineering, Nem Chand and Bros., 10th edition, 2018.

2) Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers, 2017.

3) Saxena, S. C. and Arora, S. P., A Text Book of Railway Engineering, 7th edition, Dhanpat Rai Publications, 2015.

4) Khanna, S. K., Arora, M. G. and Jain, S. S., Airport Planning and Design, VI Edition, Nemchand& Bros, 2017.

5) Rao G. V., Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996

6) Srinivasan, R., Harbour, Dock & Tunnel Engineering, 28th edition, Charotor Publishing House Pvt. Ltd., 2016.

(b) REFERENCES

7) Partho Chakraborty and Animesh Das, Principles of Transportation Engineering.

8) IRC: 37 - 2018 (2018), Guidelines for the Design of Flexible Pavements, Indian Roads Congress, New Delhi.

9) O' Flaherty, C.A (Ed.)., Transport Planning and Traffic Engineering, Elsevier, 1997

10) Papacostas, C. S. and Prevedouros P. D., Transportation Engineering and Planning, 2007.

11) Yoder, E. J and Witezak, M. W, Principles of Pavement Design, John Wiley & Sons, 1991.

12) Sustainable Urban Transport Shanghai Manual – A Guide for Sustainable Urban Development in the 21st Century.

v) COURSE PLAN

Module	**Contents**	**No. of hours**
I	Introduction to Transportation Engineering, Role of transportation in the development of a society, Classification of roads, Typical cross sections of roads in urban and rural area.	**10**

	Introduction to geometric design of highways, highway cross section elements.	
II	Introduction of flexible and rigid pavements. Introduction to highway materials, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Construction of bituminous pavements and rigid pavements (Basics only)	**12**
III	Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service, Design Speed, Traffic signals and markings, Types of road intersections, Traffic control devices (Introduction only)	**12**
IV	Railway Engineering - Component parts of a railway track - functions, concept of Gauges, coning of wheels Harbours – classification, features, requirements. Break waters - necessity and functions, classification. Docks – Functions and types - dry docks, wet docks (Introduction only) Airport Engineering - Components of airport and airport layout, Runway orientation, Taxiways, aprons. and Terminal Building (Introduction only)	**14**
V	Transportation Planning -Need for Transportation planning, Transport-land use interaction, Travel Demand Estimation – (Introduction only) Sustainable urban transport; issues and challenges, Emerging concepts in sustainable transportation: green vehicles and green roads, green and alternate fuels.	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20G	CLIMATE CHANGE AND HAZARD MITIGATION	OEC	4	0	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to expose the students to the concept of fundamentals of climate, climate change, climate models, impacts of climate change on ecosystems, and to make them aware of the appropriate actions to adopt various hazard mitigation measures.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Describe the basic physical principles of the global climate system.	Understand
CO 2	Describe the large-scale climatic changes which have influenced the ecosystem.	Understand
CO 3	Discuss the actions in key sectors to mitigate hazards due to climate change.	Apply
CO 4	Explain the international initiatives which support countries to address the climate change challenges.	Understand
CO 5	Discuss the impact of climate change on ecosystem.	Apply

iii) SYLLABUS

Introduction to Earth's Climate System, Basic concepts, Atmospheric structure and thermodynamics: pressure, density, composition, temperature structure, water in the atmosphere.

Hurricanes and Global warming, El Nino and its effects, Paleo, indicators of climate, Greenhouse effect, Carbon Cycling, Climate and Weather Global warming potential .

Climate data and Models, Analyses of climate data. Climate projections and their uncertainties, Impacts of climate change on Surface temperature, Precipitation, Ocean pH, Sea-level and Arctic sea-ice extent.

International initiatives to address the climate change challenges, IPCC, Mission of the IPCC. The Framework Convention on Climate Change, The Kyoto Protocol to the Framework Convention, Earth Summit, Montreal Protocol, Internationally Adopted Emissions Restrictions.

Climate Change Adaptation & Mitigation Measures, Adaptation to climate change in the fields of Ecosystems and biodiversity, Hazards due to climate change and Mitigation Measures, Extreme weather events. Mitigation measures in sectors vital to humanity, Energy efficiency in buildings.

iv) (a) TEXTBOOKS

1) Mark Masli, Climate Change: A Very Short Introduction, Oxford University Press, 3rd edition, 2014.
2) Archer,D&Rahmstorf, S., The Climate Crisis, An Introductory Guide to Climate Change, Cambridge University Press, 2010
3) Markandya, A., Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002
4) Kumar, D. S., Climate Change – An Indian Perspective, Cambridge University Press India Pvt. Ltd, 2007

(c) REFERENCES

5) IPCC fourth assessment report - Working Group II Report, Impacts, Adaptation and Vulnerability, 2007.
6) IPCC fourth assessment report - Working Group III Report Mitigation of Climate change, 2007
7) IPCC fifth assessment report - The AR5 synthesis report, 2014
8) IPCC fifth assessment report-The AR5 Climate Change 2014: Mitigation of Climate Change
9) IPCC fifth assessment report-TheAR6 Climate Change 2021: Mitigation of Climate Change

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Earth's Climate System: Basic concepts- Radiation, Albedo, Emissivity, scales of motion, large-scale motion, general circulation, troposphere-stratosphere transport. Atmospheric structure and thermodynamics: pressure, density, composition, temperature structure, water in the atmosphere. Atmospheric photochemistry and chemical kinetics	11
II	Hurricanes and Global warming: Global Ocean Circulation - El Nino and its effects - Paleo- indicators of climate -The Nature of Storms—cyclones, tornadoes and hurricanes. Greenhouse effect -greenhouse gases-sources of emission - The Role of Carbon Dioxide, The Earth's Carbon Reservoirs, Carbon Cycling-Climate and Weather Global warming potential - Effects of Global warming- Gandhian ideas on global warming.	11
III	Climate data and Models: Equations of atmospheric fluid mechanics, energy equation, turbulence, mixing length models, Atmospheric chemical transport and general circulation models. Analyses of climate data. Climate projections and their uncertainties. Impacts of climate change on Surface temperature, Precipitation, Ocean pH, Sea-level and Arctic sea-ice extent.	12
IV	International initiatives to address the climate change challenges: History of Earth's climate – 1970s (IIASA, DOE), 1980s, Startup of the U.N	13

	IPCC, Mission of the IPCC, The Framework Convention on Climate Change, The Kyoto Protocol to the Framework Convention, Earth Summit, Montreal Protocol. Policy Analyses, Internationally Adopted Emissions Restrictions.	
V	Climate Change Adaptation & Mitigation Measures: Adaptation to climate change in the fields of Ecosystems and biodiversity - Agriculture and food security, land use, forestry, human health, water supply, sanitation and infrastructure. Hazards due to climate change and Mitigation Measures: Extreme weather events. Mitigation measures in sectors vital to humanity (food, water, health): Brief explanation of - Carbon dioxide capture and storage (CCS), Bio-energy crops, Energy efficiency in buildings.	**13**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M20H	BUILDING DRAWING AND ESTIMATION	MINOR	3	1	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to expose the student to the concept of building drawing and computer aided drafting. The course also provides an awareness regarding specifications, analysis of rates, valuation etc. in connection with construction. The course also helps to develop skills in preparing detailed estimate using Data book and Schedule of rates.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basics of building drawing and various building rules.	Understand
CO 2	Apply the knowledge of building drawing and building rules to develop plan, section and elevation of residential buildings.	Apply
CO 3	Explain the specifications for various items of work associated with building construction	Understand
CO 4	Examine the rates of different items of work associated with building construction	Apply
CO 5	Prepare detailed estimates of buildings	Apply
CO6	Explain the types of valuation and depreciation	Understand
CO7	Calculate the value of buildings by different methods	Apply

iv) SYLLABUS

Concept of plan of a simple residential building, Principles of planning, Building rules, Design process and role of CAD, Application of CAD in building drawing. Specifications- Analysis of rates- CPWD data book and schedule of rates- Detailed specification, preparation of data and analysis of rates for various items of work- Quantity Surveying- Types of Estimate - Valuation- Methodsof valuation-Depreciation- Fixation of rent- Detailed estimate including quantities, abstract and preparation of various items of works

v) (a) TEXT BOOKS

1) Allen, E. and Iano, J., *Fundamentals of Building Construction: Materials and Methods*, John Wiley & Sons, 7th Edition, 2019.

2) Dutta B. N., *Estimating and Costing in Civil Engineering*, USB Publishers and Distributers Ltd, 27th revised edition, 2016
3) Vazirani V. N. and S. P. Chandola, *Civil Engineering Estimating and Costing*, Khanna Publishers, 6th edition, 2015
4) Bhavikatti, S. S. and Chitawadagi, M. V., *Building Planning and Drawing*, I.K. International Publishing House Pvt. Ltd, 2014.
5) D D Kohli, RC Kohli, *A textbook of Estimating and costing*, S Chand Publishing, 13thedition, 2013
6) Chakrabarti M., *Estimating and Costing in Civil Engineering*, USB Publishers and Distributers Ltd, 29th edition, 2006

(b) OTHER REFERENCES

7) *Kerala Municipality/ Panchayath Building Rules*, Kerala Government, 2019.
8) Chudley, R. and Greeno, R., *Building Construction Handbook*, Addison Wesley, Longman group, England, 2016.
9) IS 1200-1968, *Methods of Measurement of Building & Civil Engineering Works,* Bureau of Indian Standards, New Delhi, 1968
10) CPWD data book and schedule of rates, Ministry of Housing & Urban Affairs, New Delhi

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition and concept of plan of a simple residential building, Principles of planning, Elementary principles and basic requirements for building planning. Building drawing – plan, elevation and section of a residential building.	15
II	Building rules - provisions in Kerala municipality/panchayath building rules. The Design process and role of CAD in building drawing, Computer aided drafting - plan section and elevation of residential building	15
III	Quantity Surveying- Basic principles-Types of Estimates - Specifications - General and Detailed specifications-Method of measurement of various items of work. Analysis of rates- Introduction to the use of CPWD data book and schedule of rates- conveyance and conveyance statement - Miscellaneous charges. Preparation of data and analysis of rates for various items of work connected with building construction with reference to Indian Standard Specification.	15
IV	Detailed estimate including quantities, abstract and preparation of various items of works in buildings- center line method and long wall short wall method	15

V	Valuation - Explanation of terms, types of values, sinking fund, years purchase, Depreciation - Straight line method, constant percentage method, S.F method .Obsolescence. Valuation of real properties-rental method, profit based method, depreciation method. Valuation of landed properties (numerical problems not needed) - belting method, development method, hypothecated building scheme method. Rent calculation. Lease and Lease hold property	**15**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30A	STRUCTURAL MECHANICS	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: ES0U10A ENGINEERING MECHANICS

ii) COURSE OVERVIEW:

Goal of this course is to help students develop their analytical and problem-solving skills. The course introduces students to the various internal effects induced in structural members as well as their deformations due to different types of loading. After this course students will be able to analyse simple structural systems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamentals of mechanics of linear elastic deformable bodies and the behavior/response of various structural elements under various loading conditions.	Understand
CO 2	Evaluate the stresses/strains in structural elements subjected to axial load and bending/twisting moments.	Apply
CO 3	Analyse statically determinate beams and trusses to determine the internal forces.	Apply
CO 4	Analyse the deflection of statically determinate beams.	Apply
CO 5	Analyse statically indeterminate beams and frames.	Apply

iv) SYLLABUS

Review of statics, Concept of stress and strain – types, Stress – strain relation - Hooke's law, Young's modulus of elasticity. Axially loaded bars with uniform cross section–stress, strain and deformation. Deformation of axially loaded bars with varying cross section and bars with varying axial loads. Torsion of circular shafts, Power transmitted by circular shafts.

Analysis of truss, Beams – different types, types of loading on beams, Concept of bending moment and shear force. Shear force and bending moment diagrams of beams for different type of loads.

Theory of simple bending, assumptions and limitations. Calculation of normal stress in beams, moment of resistance Shear stress in beams (concept only). Moment-curvature relation. Deflection of beams by successive integration. Macaulay's method.

Statically indeterminate structures, degree of static and kinematic indeterminacy. Fixed beam – fixed end moments for simple cases of loading (No analysis required). Method of consistent deformation - Analysis of propped cantilever beam and continuous beams with maximum two redundants.

Slope deflection method, Analysis of frames with sway, analysis of continuous beams and frames without sway.

v) (a) TEXT BOOKS

1) Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall International Series.
2) James M Gere, S.P. Timoshenko, Mechanics of Materials, CBS Publishers and Distributors, New Delhi. CIVIL ENGINEERING
3) R. K. Bansal, A Text book of Strength of Materials, Laxmi Publications (P) Ltd, New Delhi.

(b) OTHER REFERENCES

4) R.C. Hibbeler, Structural Analysis, Pearson.
5) Devdas Menon, Structural Analysis, Narosa Publications.
6) H. J. Shah and S. B. Junnarkar, Mechanics of Structures Vol - I, Charotar Publishing House.
7) S. Ramamrutham and R. Narayanan, Strength of Materials, Dhanpat Rai Publishing Co (P) Ltd.
8) B. C. Punmia, Ashok K. Jain, Arun Kumar Jain, Mechanics of Materials, Laxmi Publications (P) Ltd, New Delhi.

vi) COURSE PLAN

Module	**Contents**	**No. of hours**
I	Review of statics – equilibrium conditions, free body diagrams, centroid, moment of inertia., Concept of stress, types of stresses. Concept of strain, types of strains. Stress – strain relation - Hooke's law, Young's modulus of elasticity. Stress-strain ($\sigma\sigma - \varepsilon\varepsilon$) diagram of mild steel. Axially loaded bars with uniform cross section– calculation of stress, strain and deformation. Deformation of axially loaded bars with varying cross section. Stepped bars, deformation of axially loaded bars with varying axial loads, Torsion of circular shafts, assumptions, derivation of torsion equation. Variation of stress across the cross section. Polar modulus. Calculation stress and deformation of circular shafts subjected to torsion. Power transmitted by circular shafts.	**12**
II	Analysis of truss – Method of joints, Method of sections; Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Shear force and bending moment diagrams. Shear force and bending moment diagrams of cantilever beams subjected to point load, uniformly distributed load, uniformly varying load and concentrated moment. Shear force and bending moment diagrams of cantilever beams subjected to point load, uniformly distributed load, uniformly varying load and concentrated moment.	**12**
III	Theory of simple bending – derivation of equation, assumptions and limitations. Calculation of normal stress in beams, moment of resistance. Problems involving bending stress. Shear stress in beams (concept only)-variation of shear stress across the cross section. Moment-curvature relation. Basic differential equation for calculating the deflection of beams.	**12**

	Calculation of deflection by successive integration. Principle of superposition. Macaulay's method - Deflection of cantilever beam subjected to point load and uniformly distributed loads. Macaulay's method - Deflection of simply supported beams subjected to point load and uniformly distributed loads. Clerk Maxwell's theorem of reciprocal deflection	
IV	Statically indeterminate structures, degree of static and kinematic indeterminacy - examples Force and displacement method of analysis (concept only). Fixed beam – fixed end moments for simple cases of loading (No analysis required). BMD of fixed beam, point of contraflexure. Method of consistent deformation - Analysis of propped cantilever beam. Method of consistent deformation – analysisof beams with maximum two redundants.	**12**
V	Slope deflection method – equation (no derivation required). Analysis of continuous beams with maximum two unknowns. Slope deflection method – analysis of continuous beam with support settlement. Slope deflection method – analysis of frames with sway. Moment distribution method – concept. Distribution factor and carry over moment. Moment distribution method – analysis of continuous beams. Moment distribution method – analysis of frames without sway	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30B	ECO-FRIENDLY TRANSPORTATION SYSTEMS	MINOR	3	1	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

Goal of the course is to introduce the principles and practice of sustainability on transportation systems and development of an eco-friendly transport system.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basic principles of sustainability to infrastructure related problems	Understand
CO 2	Analyse Transportation network for eco-friendliness and quantify the levels.	Apply
CO 3	Examine the design of eco-friendly transportation systems	Apply
CO 4	Apply concepts of sustainability in developing green fuels and vehicles.	Apply
CO 5	Examine the dDesign for sustainability in public transport, Applications of tools like GIS, GPS.	Apply

iv) SYLLABUS

Introduction to the concept of sustainability, basic principles. Transport networks basics, Performance measures, Advanced transport systems. Design for eco-friendly Transportation, Professional praxis in sustainability, concept and applications. Emerging concepts in sustainable transportation: green vehicles and green roads Sustainable public transport: Promoting public transport, Transit oriented Transit oriented development, integrated multi-modal transport.

v) (a) TEXT BOOKS

1) Chisty, J, Lall, K. Introduction to Transportation Engineering. PHI
2) O' Flaherty, C.A (Ed.)., Transport Planning and Traffic Engineering, Elsevier.
3) Jeffrey Tumlin: Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities, John Wiley & Sons

(b) OTHER REFERENCES

4) Green Transportation Logistics: The Quest for Win-Win Solutions Editors: Psaraftis, Harilaos N. (Ed.), Springer.

5) Thomas Abdallah: Sustainable Mass Transit: Challenges and Opportunities in Urban Public Transportation.
6) Chester Patton, Public Transit Operations: The Strategic Professional
7) Sustainable and Efficient Transport: Incentives for Promoting a Green Transport MarketEdited by Ellen Eftestøl-Wilhelmsson, et al, Edward Elgar
8) Rani Iyer:Green Transport: Exploring Eco-Friendly Travel for a Better Tomorrow: 6. Smart City project reports.
9) Environmental Impact Assessment Reports on Infrastructure projects.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Sustainability: Definition, concepts, Environmental impacts of infrastructure projects, depletion of natural resources and pollution. Problems of present transportation systems, performance analysis. Introduction to eco-friendly systems.	**12**
II	Transportation network basics: network planning, design, operation and management (elementary ideas only), Measures of network performance, factors and parameters. Introduction to advanced transport systems: metro, monorail, maglev, hyperloop.	**12**
III	Eco-friendly transport: Necessity, Basics: reducing natural fuels, Eco-friendly transport network. Parameters, design, implementation. Professional praxis in sustainability: concepts, practical applications. Paradigm shift: Mobility and accessibility.	**12**
IV	Emerging concepts in sustainable transportation: green vehicles and green roads: basics and necessity. Green vehicles: minimizing fuel consumption, alternate fuels. Green pathways: sustainable design, construction, Forgiving designs for safety, ITS applications.	**12**
V	Sustainable public transport: Promoting public transport, Fleet management and scheduling: Concepts and tools only. Transit oriented development (smart cities), integrated multimodal transport, GIS applications. Micro projects: i) Compilation of studies on green fuels and transport, with comparison. ii) A study on literature available on a typical smart city project, in the transport context, and propose designs. (may be given as assignments)	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30C	SUSTAINABILITY ANALYSIS AND DESIGN	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

Goal of the course is to introduce various tools and techniques of sustainability analysis and its significance in design and engineering decision making.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the impacts of various materials and processes on the biosphere.	Understand
CO 2	Identify the parameters used in the calculation of sustainability.	Understand
CO 3	Estimate sustainability metrics for application-material combinations.	Apply
CO 4	Apply concepts of sustainability in developing green fuels and vehicles.	Apply
CO 5	Apply the design approaches by integrating sustainability concepts.	Apply

iv) SYLLABUS

Introduction to sustainability - Sustainable use of materials: Energy, ecology and natural resources engineering design process-Role of materials in design: important material characteristics, construction ecology and metabolism - specifications and market.

Material flow analysis - efficiencies in mass flow — Constructing a material flow system—embodied energy—engineering models based on waste and materials management.

Sustainability metrics — mass balance and footprint concept Sustainable design - Specifications for sustainable material use — waste management and material life cycles - Environmentally sensitive design — Green engineering.

Life-cycle assessment—Life cycle assessment framework-Inventory analysis —impact assessment – interpretation.

Sustainable designs approaches - Sustainable urbanization – sustainable cities –sustainable transport - energy efficiency.

v) (a) TEXT BOOKS

1) Allen, D. T and Shornard, D R, Sustainability Engineering, Concepts, Designand Case Studies, Prentice Hall.
2) Bradley A. S., Adebryo, A. 0., Maria P., Engineering Applications in Sustainable Design and Development, Cengige Learning Jeffrey Tumlin: Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities, John Wiley & Sons

(b) OTHER REFERENCES

4) UNDP (1987), Our Common Future, Report of the World Commission on Environment and Development
5) Riley, D. R., Thatche, C. E., and Workman, E. A. (2006), Developing and applying green building technology in an indigenous community: An engaged approach to sustainability education, International Journal of Sustainability in Higher Education.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to sustainability - Sustainable use of materials, Energy, ecology and natural resources, Engineering design process-Role of materials in design Construction ecology and metabolism - specifications and market.	**12**
II	Material flow analysis - efficiencies in mass flow, Constructing a material lflowsystem—embodied energy Embodied energy Engineering models based on waste and materials management.	**12**
III	Sustainability metrics — mass balance and footprint concept Sustainable design Specifications for sustainable material use Waste management and material life cycles Environmentally sensitive design — Green engineering.	**12**
IV	Life-cycle assessment—Life cycle assessment framework, Inventory analysis Impact assessment – interpretation	**12**
V	Sustainable designs approaches, Sustainable urbanization – sustainable cities, Sustainable transport - energy efficiency.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30D	SENSING AND DATA MINING FOR SMART STRUCTURES AND SYSTEMS	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to smart monitoring systems for applications in physical structures and systems. Such monitoring systems enable them to understand the performance of the physical systems and diagnose their critical status using technologies, such as sensor network and data analytics.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the fundamentals of smart materials and structures.
CO 2	Discuss the different types of sensing technologies adopted for structural assessment.
CO 3	Explain the various structural health monitoring techniques adopted in civil engineering.
CO 4	Describe the different non-destructive techniques used in civil engineering.
CO 5	Explain the signal processing and control of smart structures using data acquisition systems.

iv) SYLLABUS

Introduction to Smart Materials and Structures, Sensing systems, Measuring techniques, Strain Measuring Techniques using Electrical strain gauges, Wheatstone bridges, Pressure transducers, Load cells, Strain Rosettes, Sensing Technology, LVDT, Fiber optic Techniques, Absorptive chemical sensors, Spectroscopes, Structural Health Monitoring (SHM), Non-destructive techniques(NDT), Data Acquisition and Processing, Signal Processing and Control for Smart Structures, Electromagnetic imaging, Thermography, Elastic wave based methods, Ultrasonics.

v) (a) TEXT BOOKS

1) Srinivasan, A.V. and McFarland, D.M., *Smart Structures: Analysis and Design*, Cambridge University Press, 1st edition, 2010.
2) Gandhi, M.V. and Thompson, B.S., *Smart Materials and Structures*, Chapmann and Hall, London, 3rd edition, 2015.

3) Balageas, D., Fritzen, C.P. and Guemes, A., *Structural Health Monitoring*, Wiley-ISTE, 2006.

(b) OTHER REFERENCES

4) Addington, M. and Schodek, D.L., *Smart Materials and Technologies: For the Architecture and Design Professions*, Routledge, 1st edition, 2004.
5) Culshaw, B., *Smart Structure and Materials*, Artech House Publishers, 2016.
6) Srinath, L.S., *Experimental Stress Analysis*, Tata McGraw-Hill, 2018.
7) Dally, J.W. and Riley, W.F., *Experimental Stress Analysis*, College House Enterprises, 4th edition, 2015.
8) Adams, D.E., *Health Monitoring of Structural Materials and Components-Methods with Applications*, John Wiley and Sons, 4th edition, 2017.
9) Ostachowicz, W. and Guemes, J.A., *New Trends in Structural Health Monitoring,* Springer, 1st edition, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Smart Materials and Structures-Smart composites-advantages and limitations. History, production and areas of application of the above materials. Measuring techniques: Strain Measuring Techniques using Electrical strain gauges, Types – Resistance, Capacitance, Inductance, Wheatstone bridges, Pressure transducers, Load cells, Temperature Compensation, Strain Rosettes.	12
II	Sensing Technology: Types of Sensors, Physical Measurement using Piezo Electric Strain measurement, Inductively Read Transducers, The LVDT, Fiber optic Techniques Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors, Spectroscopes, Fibre Optic Chemical Sensing Systems and Distributed measurement.	12
III	Introduction to Structural Health Monitoring (SHM): Necessity of SHM, Vibration based damage detection, Sensor based SHM of civil structures – optical, piezoelectric and non-contact approaches. Numerical modelling, analysis of structures and inverse analysis. Application of structural health monitoring.	12
IV	Non-destructive techniques (NDT): Necessity of NDT, General methods of NDT of civil engineering structures according to Indian	12

	Standards, Imaging as a tool for NDT – A scan, B scan, C scan, time of flight based reconstruction, synthetic aperture focusing technique. Non-destructive methods of testing piles- X-ray, DTA analysis, Photo elasticity methods for structural classification of soil	
V	Data Acquisition and Processing: Signal Processing and Control for Smart Structures, Signal Processing, Control System – Linear and Non-Linear. Electromagnetic imaging: Fundamentals, ground penetrating radar; Thermography-fundamentals, Infrared thermography; Elastic wave based methods-impact echo, Ultrasonics-fundamentals, instrumentation, imaging methodologies; Future directions.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30E	ESTIMATION AND COSTING	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to introduce the various types of estimation, specification writing, analysis of rate and various methods to determine the valuation of building. It enables the students to prepare the detailed estimate of various items of work related to civil engineering construction. This course trains the student to find out the valuation of building by various methods.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the specifications for various items of work associated with building construction	Understand
CO 2	Analyse the unit rates of different items of work associated with building construction	Apply
CO 3	Prepare the approximate estimate of building	Apply
CO 4	Prepare detailed estimates of tanks, septic tanks and soak pits.	Apply
CO 5	Explain the basic concepts of valuation in buildings.	Understand
CO 6	Estimate the value of buildings by different methods.	Apply

iii) SYLLABUS

Specifications, Analysis of rates, CPWD data book and schedule of rates. Detailed specification, preparation of data and analysis of rates for various items of work. Quantity Surveying, Types of Estimate, Valuation, Methods of valuation, Depreciation, Fixation of rent, Detailed estimate including quantities, abstract and preparation of various items of works.

iv) (a) TEXT BOOKS

1) Dutta, B.N., *Estimating and Costing in Civil Engineering*, USB Publishers and Distributers Ltd, 27th revised edition, 2016.
2) Vazirani, V.N., and Chandola, S.P., *Civil Engineering Estimating and Costing*, Khanna Publishers, 6th edition, 2015.
3) Kohli, D.D. and Kohli, R.C., *A textbook of Estimating and costing*, S Chand Publishing, 13th edition, 2013.
4) Chakrabarti, M., *Estimating and Costing in Civil Engineering*, USB Publishers and Distributers Ltd, 31st edition, 2014.

(b) OTHER REFERENCES

1) IS 1200-1992 (Re-affirmed 2002), *Methods of Measurement of Building & Civil Engineering Works,* Bureau of Indian Standards, New Delhi, 2002.
2) Patil, B.S., *Civil Engineering contracts and estimates*, Universities Press, 3rd edition, 2006.
3) Deathrage, G.E., *Construction Schedule & Control*, McGraw Hill, 1965.
4) *CPWD data book and schedule of rates*, Ministry of Housing & Urban Affairs, New Delhi.

v) COURSE PLAN

Module	Contents	No. of hours
I	Quantity Surveying- Basic principles-Types of Estimates -Specifications -General and Detailed specifications-Method of measurement of various items of work. Analysis of rates- Introduction to the use of CPWD data book and schedule of rates- conveyance and conveyance statement -Miscellaneous charges.	**12**
II	Preparation of data and analysis of rates for various items of work connected with building construction with reference to Indian Standard Specification.	**12**
III	Detailed estimate including quantities, abstract and preparation of various items of works in buildings - center line method and long wall short wall method.	**12**
IV	Detailed estimate including quantities, abstract and preparation of various items of works- sanitary and water supply works- soak pits and septic tanks. Detailing and bar bending schedule of beams, columns, isolated footing and slabs.	**12**
V	Valuation - Explanation of terms, types of values, sinking fund, years purchase, Depreciation - Straight line method, constant percentage method, S.F method .Obsolescence. Valuation of real properties-rental method, profit based method, depreciation method. Valuation of landed properties (numerical problems not needed) - belting method, development method, hypothecated building scheme method. Rent calculation. Lease and Lease hold property.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE030MF	GEOTECHNICAL INVESTIGATION & GROUND IMPROVEMENT TECHNIQUES	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: CE1U20E GEOTECHNICAL ENGINEERING I

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to various methods of soil exploration, to recognize weak soils based on the soil investigation reports and to analyze suitable remedial measures to improve the properties of weak soils. After this course, students will be able to recognize practical problems in real-world situations and respond accordingly.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain soil exploration methods	Understand
CO 2	Explain different methods of ground improvement techniques with and without addition of other materials.	Understand
CO 3	Identify various types, functions and practical applications of Geosynthetics	Apply
CO 4	Describe the application Reinforced Earth Retaining Walls, Gabions Soil nailing	Apply
CO 5	Solve the field problems related to geotechnical engineering by applying ground improvement techniques	Apply

iv) SYLLABUS

Site investigation and soil exploration: Introduction and practical importance, Planning of a sub-surface exploration program Preliminary investigation - Detailed investigation advantages and disadvantages -Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Sampling - disturbed samples, undisturbed samples and chunk samples - Types of samplers, Rock Quality Designation

Sounding and Penetration Tests - Standard Penetration, Factors influencing the SPT results and precautions to obtain reliable results – Merits and drawbacks of the test - Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test (DCPT), Geophysical methods :

Seismic Refraction method and Electrical Resistivity method – Brief Procedure - Merits/drawbacks

Ground Improvement Techniques : Introduction – Objectives - Soil improvement without the addition of any material : Shallow and Deep Compaction, Dynamic compaction - Compaction piles - Blasting technique - Vibro compaction– Vibroflotation Preloading techniques – sand drains

Soil improvement by adding materials: Grouting – materials - Grouting systems Practical Applications - Grouting Plant and equipment - Grouted columns – Curtain and blanket grouting – Practical applications - Lime stabilization –Mechanism optimum lime content-lime fixation point.

Soil improvement using Geosynthetics : Materials, Types of Geotextiles and Geogrids - Functions of Geosynthetics - Practical applications - Introduction to reinforced earth Soil Nailing – Introduction – practical applications.

v) (a) TEXT BOOKS

1) Ranjan G. And A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.
2) Purushotham S. Raju, Ground Improvement Technique, Laxmi Publications, 2012

(b) OTHER REFERENCES

3) Shashi K. Gulhati and Manoj Dutta, Geotechnical Engineering, Tata McGraw-Hill Publishing CompayLimited,New Delhi, 2008.
4) Venkatramaiah, Geotechnical Engg, Universities Press, 2000.
5) Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.
6) Moseley, Text Book on Ground Improvement, Blackie Academic Professional, Chapman & Hall, 2004.
7) Boweven R., Grouting in Engineering Practice, Applied Science Publishers Ltd.
8) Sivakumar Babu, G. L., An introduction to Soil Reinforcement and Geosynthetics, Universities Press (India) Private Limited, 2006.
9) Jewell R.A., Soil Reinforcement with Geotextiles, CIRIA Special Publication, Thomas Telford

vi) COURSE PLAN

Module	Contents	No. of hours
I	Site investigation and soil exploration: Introduction and practical importance – objectivesPlanning of a sub-surface exploration program – Reconnaissance – Preliminary investigation - Detailed investigation - methods of subsurface exploration – direct methods - Open pits and trenches - Semi direct methods – Borings - Auger boring – Shell and	**12**

	Auger Boring - Wash boring, percussion drilling and rotary drilling – advantages and disadvantages -Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Sampling - disturbed samples, undisturbed samples and chunk samples - Types of samplers – Split spoon sampler – Thin-walled sampler – Piston sampler - Rotary sampler – Core Recovery and Rock Quality Designation	
II	Sounding and Penetration Tests - Standard Penetration Test – Procedure - Corrections to be applied to observed N values – Numerical examples - Factors influencing the SPT results and precautions to obtain reliable results – Merits and drawbacks of the test - Correlations of N value with various engineering and index properties of soils - Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test (DCPT) – Brief Procedure - Merits/drawbacks - Boring log - soil profileLocation of Water table - Geophysical methods : Seismic Refraction method and Electrical Resistivity method – Brief Procedure - Merits/drawbacks	**12**
III	Ground Improvement Techniques : Introduction – Objectives - Soil improvement without the addition of any material : Shallow and Deep Compaction - Shallow compaction – Rollers - Deep Compaction - Dynamic compaction - Compaction piles - Blasting technique - Vibro compaction– Vibroflotation - Terra probe method - Vibro replacement - sand piles and stone columns - Preloading techniques – sand drains	**12**
IV	Soil improvement by adding materials : Grouting – materials - Grouting systems : One shot and two shot systems - Modes of grouting - Main types of grouting : Permeation Grouting, Compaction Grouting and Jet Grouting – Practical Applications - Grouting Plant and equipment - Grouted columns – Curtain and blanket grouting – Practical applications - Lime stabilization –Mechanismoptimum lime content-lime fixation point.	**12**
V	Soil improvement using Geosynthetics : Materials of Geosynthetics - Types of Geosynthetics - Types of Geotextiles and Geogrids - Functions of Geosynthetics - Practical applications - Introduction to reinforced earth – principles – reinforcing materials - Reinforced earth retaining walls – components – construction sequence – practical applications - Gabions – Introduction - practical applications - Soil Nailing – Introduction – practical applications.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30G	ENVIRONMENTAL HEALTH AND SAFETY	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

Goal of this course is to build environmental health literacy among students and encourages them to take safety measures against various environmental hazards. It motivates the students in maintaining and improving the quality of the environment and empower learners to take appropriate actions to reduce the environment pollution.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Understand the toxicology and Occupational Health associated with industries.	Understand
CO 2	Identify chemical and microbial agents that originate in the environment and can impact human health.	Apply
CO 3	Describe various measures to ensure safety in Construction industry	Apply
CO 4	Explain the effect of air and water pollution on environment.	Understand
CO 5	Describe the safety measures against various environmental hazards.	Apply

iv) SYLLABUS

Introduction to Occupational Health And Toxicology: Safety at work, occupational related diseases, Toxic materials and substances used in work, exposure limits, toxicological investigation, Industrial Hygiene, Arrangements by organisations to protect the workers.

Chemical hazards, Methods of Control, Biological hazards, Classification of Biohazardous agents, Noise, noise exposure regulation and control.

Safety in Construction industry, Electrical Hazards, Protection against voltage fluctuations, Effects of shock on human body. Radiation Hazards

Air Pollution, depletion of ozone layer, Water Pollution, Waste Management,characterization and classification, recycling and reuse.

Safe working environment, Role of an individual in conservation of natural resources, Methods for controlling water pollution, role of individual in prevention of pollution.

v) (a) TEXT BOOKS

1) Environmental and Health and Safety Management by By Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995.
2) Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005.
3) The Facility Managers Guide to Environmental Health And Safety by Brian Gallant, Government Inst Publ., 2007.
4) R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006).
5) Mackenzie L Davis, Introduction to Environmental Engineering, McGrawhill Education (India).

(b) OTHER REFERENCES

6) Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.
7) Heinrich H.W, Industrial Accident Prevention, McGraw Hill Company, NewYork, 2003.
8) S. P. Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Occupational Health And Toxicology : Safety at work – Socio – Economic reasons. Introduction to health and safety at various industries. occupational related diseases-Musculoskeletal disorders, hearing impairment, carcinogens, silicosis, asbestosis, pneumoconiosis – Toxic materials and substances used in work, exposure limits, toxicological investigation, Industrial Hygiene, Arrangements by organisations to protect the workers.	12
II	Chemical hazards-dust, fumes, vapour, fog, gases, Methods of Control. Biological hazardsClassification of Biohazardous agents– bacterial agents, viral agents, fungal, parasitic agents, infectious diseases, control of biological agents at workplaces. Noise, noise exposure regulation and control.	12
III	Safety in Construction industry - Scaffolding and Working platform, Welding and Cutting, Excavation Work, Concreting, control measures to reduce the risk. Electrical Hazards, Protection against voltage fluctuations, Effects of shock on human body. Radiation Hazards, Types and effects of radiation on human body, disposal of radioactive waste.	12

IV	Air Pollution - air pollutants from industries, effect on human health, animals, Plants and Materials - depletion of ozone layer-concept of clean coal combustion technology. Water Pollution - water pollutants-health hazards - effluent quality standards. Waste Management -waste identification, characterization and classification, recycling and reuse.	**12**
V	Safe working environment - The basic purpose and benefits of safety inspection, First-aid appliances, Shelters, rest rooms and lunch rooms, use of personal protective equipment, Role of an individual in conservation of natural resources, Methods for controlling water pollution, role of individual in prevention of pollution.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M30H	CONSTRUCTION QUALITY MANAGEMENT	MINOR	4	0	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW:

The goal of this course is to expose student to the concept of total quality management in construction, constructions quality control and monitoring, statistical quality control and quality standards.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain total quality management and its applications.	Understand
CO 2	Apply quality control aspects of construction activities.	Apply
CO 3	Explain statistical quality control and management.	Understand
CO 4	Outline quality standards in construction materials and activities.	Understand
CO 5	Explain ISO 9000 - Quality Management System.	Understand

iv) SYLLABUS

Concept of quality control, Quality assurance, Quality management. Aims of Total Quality Management in construction, Duties, responsibilities, qualification of staff in organization, Quality of material. Statistical Quality Control, Quality Measurement, Quality standards in construction related to building materials and activities, ISO 9000 Quality management system.

v) (a) TEXT BOOKS

1) Tang, S.L., Ahmed, S.M., Raymond, T.A. and Poon, S.W., *Construction Quality Management*, Hong Kong University Press, 2005.
2) Oakland, J.S. and Marosszeky, M., *Total Construction Management: Lean Quality in Construction Project Delivery*, Taylor and Francis, 1st edition, 2017.
3) Thorpe, B. and Sumner, P., *Quality Management in Construction*, Gower, 3rd edition, 2005.
4) Gahlot, P.S., *Quality Management of Cement Concrete Construction*, CBS Publishers and Distributors Pvt. Ltd., 1st edition, 2013.

5) Rumane, A.R., *Quality Management in Construction Projects*, CRC Press, 2nd edition, 2017.

(b) OTHER REFERENCES

6) Bhat, K.S., *Total Quality Management*, Himalaya Publishing House, 2014.
7) Leavenworth, R. and Grant, E., *Statistical Quality Control*, McGraw Hill Education, 7th edition, 2017.
8) Bester Field, *Total Quality Management*, Pearson Education India, 4th edition, 2015.
9) ISO 9000, *Quality Management Systems*, International Organization for Standardization, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Concept of quality control, Quality assurance, Quality management. Aims of Total Quality Management in construction, Development and design Concept of TQM, Accuracy and precision in observation, reading, calibration, testing, measurements, recording of data and information etc. Accuracy in calculation, finding area, volume, etc.	**12**
II	Duties, responsibilities, qualification of staff in organization. Checklists for: Quality of Materials, Masonry, Plastering, Concrete construction- Batching, Mixing, Transporting, Placing, Compaction, Finishing, Curing. Reinforcement Work, Formwork, Timber & steel construction, Doors & windows, Plumbing & drainage.	**10**
III	Statistical Quality Control, Quality Measurement: Attributes and Variables, Statistical Process Control (SPC) Methods. Control Charts for Attributes: p-Charts - Proportion Defective, c-Charts - Number of Defects Per Unit, Control Charts for Variables, Other Types of Attribute-Sampling Plans, Acceptance Sampling	**10**
IV	Quality standards in construction related to Building materials and other inputs for construction processes. Quality standards for Construction outputs, products and services. Indian Standard Code, Use of IS for quality references. National Building code (NBC 2005), Study of International Organization for Standardization (ISO): ISO-9000, ISO14000 & certification procedures.	**12**
V	ISO 9000 – Quality Management Principles, ISO 9000 Documents Content of ISO 9001 : 2015, ISO 9001-2015 Quality Management System Requirements, General Requirements, Documentation Requirements, Management Responsibilities, Resource Management, Product Realization, Measurement, analysis and Improvement Monitoring and Measurement, Non-conforming	**12**

	Product, Analysis of data, Improvement, Implementing ISO 9001-2015 Quality Management System.	
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M49A	MINI PROJECT	VAC	0	1	6	4	2020

Preamble: Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The objective of Project Work I is to enable the student to take up investigative study in the broad field of Civil Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department to a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic
- Preparing an Action Plan for conducting the investigation, including teamwork
- Working out a preliminary Approach to the Problem relating to the assigned topic
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/Feasibility
- Preparing a written report on the study conducted for presentation to the department

i) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply the knowledge gained from the minor programme courses to identify real life engineering problems	Apply
CO2	Design proper scientific methodology to successfully complete the project	Create
CO3	Develop solutions to socially relevant practical problems by applying suitable scientific tools	Create
CO4	Assess the impact of the proposed solutions in a global, economic, environmental, and societal context	Evaluate
CO5	Communicate the project work effectively in oral and written forms	Apply
CO6	Build the culture of working effectively in a team, upholding professional and ethical responsibilities	Apply

ii) ASSESSMENT PATTERN

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva-voce examination, conducted by a 3-member committee appointed by the Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will

be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement. The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through a minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systems under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.
A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brainstorming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

iii) COURSE PLAN

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with Faculty-in-charge of mini project/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carry out the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight

iv) MARK DISTRIBUTION

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

(a) Demonstration : 50 Marks

(b) Project report : 10 Marks

(d) Viva voce : 15 Marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE0M49B	MINI PROJECT	VAC	0	1	6	4	2020

Preamble: Mini Project Phase II: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The objective of Project Work II is to enable the student to take up investigative study in the broad field of Civil Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department to a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic
- Preparing an Action Plan for conducting the investigation, including teamwork
- Working out a preliminary Approach to the Problem relating to the assigned topic
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/Feasibility
- Preparing a Written Report on the Study conducted for presentation to the Department

i) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply the knowledge gained from the minor programme courses to identify real life engineering problems	Apply
CO2	Design proper scientific methodology to successfully complete the project	Create
CO3	Develop solutions to socially relevant practical problems by applying suitable scientific tools	Create
CO4	Assess the impact of the proposed solutions in a global, economic, environmental, and societal context	Evaluate
CO5	Communicate the project work effectively in oral and written forms	Apply
CO6	Build the culture of working effectively in a team, upholding professional and ethical responsibilities	Apply

ii) ASSESSMENT PATTERN

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva-voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through a minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systems under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brainstorming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

iii) COURSE PLAN

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with Faculty-in-charge of mini project/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

iv) MARK DISTRIBUTION

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

(a) Demonstration : 50 Marks

(b) Project report : 10 Marks

(c) Viva-voce : 15 Marks

HONOURS IN CIVIL ENGINEERING

HONOURS IN CIVIL ENGINEERING

Semester	BASKET I				BASKET II				BASKET III			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S4	CE1H 20A	Advanced Mechanics of Solids	3-1-0	4	CE1H 20B	Pavement Construction and Management	3-1-0	4	CE1H 20C	Geographical Information Systems	4-0-0	4
S5	CE1H 30A	Structural Dynamics	4-0-0	4	CE1H 30B	Transportation Systems Management	3-1-0	4	CE1H 30C	Ground Water Hydrology	4-0-0	4
S6	CE1H 30D	Finite Element Methods	4-0-0	4	CE1H 30E	Earth Dams and Earth Retaining Structures	4-0-0	4	CE1H 30F	Environmental Pollution Modelling	4-0-0	4
S7	CE1H 40A	Modern Construction Materials	4-0-0	4	CE1H 40B	Soil Dynamics and Machine Foundations	4-0-0	4	CE1H 40C	Environmental Pollution Control Techniques	4-0-0	4
S8	CE1H 49A	Mini Project	0-1-6	4	CE1H 49A	Mini Project	0-1-6	4	CE1H 49A	Mini Project	0-1-6	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H20A	ADVANCED MECHANICS OF SOLIDS	VAC	3	1	0	4	2020

i) PRE-REQUISITE: CE1U20A MECHANICS OF SOLIDS

ii) COURSE OVERVIEW

Objective of this course is to expose the students to the advanced concepts of mechanics of materials and enhance their problem-solving skills. The course aims to understand the stresses and strains in 2D and 3D solid bodies. It introduces students to the elements of theories of elasticity, failure and failure criteria. Students will be able to understand concepts, principles and governing equations in dealing with elastic solids. After this course students will be in a position to find mechanical behaviour of elastic materials by determining the stress, strains produced by the application of load.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the material properties of solids and the state of stress & strain developed in deformable solids due to applied loads	Understand
CO 2	Calculate the stress tensor and strain tensor of structure subjected to external loads or by applying the constitutive relation between the stresses and strains	Analyse
CO 3	Describe the different failure theories	Remember
CO 4	Compute the Factor of Safety against structural failure	Apply
CO 5	Predict the structural response of standard cross sections of isotropic materials due to applied torsion	Apply

iv) SYLLABUS

Stress Tensor, Transformation of stress, Principal Stress, Stress Invariants, Plane stress, Mohr's Circle in Two Dimensions.

Strain Tensor, Strain Transformation, Spherical and Deviatorial Strain Tensor, Principal Strains, Strain Invariants, Mohr Circle for strain, Strain Rosettes.

Strain Energy Density, Internal Energy Density, Generalized Hooke's Law, Anisotropic Elasticity, Isotropic Elasticity, Displacements-strains and compatibility-equilibrium equations and boundary conditions

Modes of failure, yield failure criteria, Maximum Principal Stress Criteria, Maximum Shear stress criteria, Maximum Strain Criteria, Maximum Strain Energy Density Criteria, Von Mises Criteria, fatigue, Stress Concentration Factor, Palm Miner Rule, SN Curve

Torsion of a cylindrical bar of circular cross section- St.Venant's semi inverse method-stress function approach-elliptical, equilateral triangle & narrow rectangular cross sections - Prandtl's membrane analogy-Hollow thin wall torsion members

v) (a) TEXT BOOKS

1) Boresi, A.P., Sidebottom, O.M., Advanced Mechanics of Materials, John Wiley & Sons, 6th edition, 2002.
2) Cook, R.D., Young, W.C., Advanced Mechanics of Materials, Prentice Hall, 2nd edition, 1999.
3) Srinath, L.S., Advanced Mechanics of Solids, Tata McGraw Hill, 3rd edition, 2009.

(b) REFERENCES

1) Timoshenko, S. P., Strength of Materials Vol II, CBS Publishers, 3rd edition, 2002
2) Timoshenko, S.P., Goodier, J.N., Theory of elasticity, McGraw Hill, 3rd edition, 2nd reprint, 2010

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition of stress at a point, Stress Notation, Stress Tensor, Normal stress and Shearing Stress on an oblique plane, Transformation of stress, Principal Stress, Stress Invariants, Octahedral Stress, Mean and Deviator Stress, Plane stress, Mohr's Circle in Two Dimensions, Differential Equations of motion of a deformable body.	12
II	Types of Strain, Deformation of a deformable body, Strain Tensor, Strain Transformation, Spherical and Deviatorial Strain Tensor, Principal Strains, Strain Invariants, Octahedral Strains, Mohr Circle for strain, Equations of Compatibility for Strain, Strain Rosettes	12
III	Strain Energy Density, Complementary Internal Energy Density, Elasticity and Strain Energy Density, Elasticity and Complementary Internal Energy Density, Generalized Hooke's Law, Anisotropic Elasticity, Isotropic Elasticity, Displacements-strains and compatibility-equilibrium equations and boundary conditions	10
IV	Modes of failure, yield failure criteria, Maximum Principal Stress Criteria, Maximum Shear stress criteria, Maximum Strain Criteria, Maximum Strain Energy Density Criteria, Von Mises Criteria, fatigue, Stress Concentration Factor, Palm Miner Rule, SN Curve	12
V	Torsion of a cylindrical bar of circular cross section- St.Venant's semi inverse method-stress function approach-elliptical, equilateral triangle & narrow rectangular cross sections - Prandtl's membrane analogy-Hollow thin wall torsion members	14
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H20B	PAVEMENT CONSTRUCTION AND MANAGEMENT	VAC	3	1	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to introduce the principles and practice of Highway construction and infrastructure asset management.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply standard procedure to determine the characteristics of pavement materials.	Apply
CO 2	Design bituminous mixes for flexible pavements.	Apply
CO 3	Explain the different methods and equipment's used in the construction of pavements.	Understand
CO 4	Design of rigid pavements as per IRC standards.	Apply
CO 5	Evaluate the structural and functional condition of pavement.	Analyse
CO 6	Identify the most effective maintenance alternative based on the life cycle cost analysis using pavement management system.	Apply

iii) SYLLABUS

Pavement – functions and characteristics – Types of pavement: flexible pavement, rigid pavement, comparison – Different layers of flexible and rigid pavements.

Pavement Materials – Characterization of sub graded soil, soil classification system, properties of road aggregate, principles and method of gradation of soil aggregate mixes, characteristics and uses of bitumen, emulsion cutback and modified bitumen.

Bituminous pavement types – penetration layer system and premixed aggregate – specification of materials.

Mix design – physical and volumetric properties of bituminous mix, Marshall method of mix design, superpave mix design.

Construction of flexible pavement: functions of various layers, preparation and construction of sub grade, granular sub base (GSB), WBM, WMM, Bituminous macadam, Different types of wearing courses. Specifications/ guide lines, equipment used for the construction of different layers in flexible pavement, quality control for flexible pavement construction.

Construction of cement concrete pavement: material characterization, preparation of subgrade and base, Types of joints in Rigid pavements its functions and design, presetting reinforcement in joints and PCC slab construction.

Introduction to pavement management system (PMS): concept, definition, objectives, components, general structure- data collection pavement evaluation, functional and structural evaluation, pavement deterioration models, pavement management levels:

network, programme and project level- types of pavement management system, Types of Maintenance and rehabilitation activities, life cycle cost analysis of strategies, popular software.

iv) (a) TEXT BOOKS

1) Khanna, S. K., Justo, E. G. and A Veeraragavan, Highway Engineering, Nem Chand and Bros., 10th edition, 2018.
2) Kadiyali, L. R., Principles of Highway Engineering, Khanna Publishers,2001
3) Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering CRC press,2009
4) Rao G. V, Principles of Transportation and Highway Engineering, Tata McGraw Hill, 1996
5) Prithvi Singh Khandhal, Bituminous Road Construction in India, PHI Learning,2019.

(d) REFERENCES

1) Manual for construction and supervision of Bituminous works, MoRTH2001
2) Shahin M.Y, Pavement Management for Airports, Roads and Parking lots, Chapman & Hall,2005
3) IRC: 37-2018, Guidelines for the Design of Flexible Pavements, IRC 2018, New Delhi
4) MoRTH, IRC code for pavement evaluation, data collection

v) COURSE PLAN

Module	Contents	No. of hours
I	Pavement – functions and characteristics – Types of pavement: flexible pavement, rigid pavement, comparison – Different layers of flexible and rigid pavements. Pavement Materials – Characterization of sub graded soil, soil classification system, properties of road aggregate, principles and method of gradation of soil aggregate mixes, characteristics and uses of bitumen, emulsion cutback and modified bitumen.	14
II	Bituminous pavement types – penetration layer system and premixed aggregate – specification of materials. Mix design – physical and volumetric properties of bituminous mix, Marshall method of mix design, superpave mix design.	14
III	Construction of flexible pavement: functions of various layers, preparation and construction of sub grade, granular sub base (GSB), WBM, WMM, Bituminous macadam, Different types of wearing courses. Specifications/ guide lines, equipment used for the construction of different layers in flexible pavement, quality control for flexible pavement construction.	10
IV	Construction of cement concrete pavement: material characterization, preparation of subgrade and base, Types of joints in	10

	Rigid pavements its functions and design, presetting reinforcement in joints and PCC slab construction.	
V	Introduction to pavement management system (PMS): concept, definition, objectives, components, general structure- data collection pavement evaluation, functional and structural evaluation, pavement deterioration models, pavement management levels: network, programme and project level- types of pavement management system, Types of Maintenance and rehabilitation activities, life cycle cost analysis of strategies, popular software.	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H20C	GEOGRAPHICAL INFORMATION SYSTEMS	VAC	4	0	0	4	2020

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts and components of Geographical Information System (GIS) and enable them to identify the requirements for the development of GIS module for various applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the basic concepts and operations in GIS	Understand
CO 2	Discuss various data types and their characteristics	Understand
CO 3	Illustrate various approaches of spatial data analysis and their significance in decision making	Apply
CO 4	Demonstrate the application of GIS and allied technologies across diverse fields	Apply

iii) SYLLABUS

Basic concepts of GIS , history of GIS, components of GIS geospatial data, attribute data, GIS operations, application of GIS , popular GIS softwares. Co-ordinate system: Geographic Co-ordinate system, Map Projections, commonly used Map Projections, Projected coordinate system, Georeferencing, Geometric Transformations.

Data structure-Vector Data model, Raster Data model, Types of Raster data, Data inputs to GIS platform, Metadata, Vector to Raster conversion, Digitization. Database management and map making: Geodatabase management, Attribute data management. Cartography and map making elements.

GIS Data Processing – Vector data Analysis- Buffering, Overlay Point-in-Polygon, Line-in-polygon, Polygon-in-polygon, Distance measurement, Pattern analysis, Map manipulation, Network Analysis. Raster Data Analysis- Local operations, Neighbourhood operation, Zonal Operation, other Raster data operations.

Advanced Applications: Introduction to terrain mapping, DEM and TIN, terrain mapping techniques, Slope and aspect, WebGIS. Data quality analysis – Sources of error – Components of data quality.

Remote sensing: Basic principles, Application of remote sensing in GIS. Global Positioning System (GPS) - GPS basic concepts, GPS segments-satellites & receivers, GPS applications. Application of GPS data in GIS environment.

iv) (a) TEXT BOOKS

1) Chang,K., *Introduction to Geographic Information Systems*, Tata McGraw-HillPublishing Co. Ltd,9th edition, 2020.
2) Joseph, G.,*Fundamentals of Remote Sensing*, University Press, 2005.
3) Laurini, R. andThompson, D., *Fundamentals of Spatial Information Systems*, Academic Press, 1996.

(b) REFERENCES

1) Burrough P., *Principles of Geographical Information systems,* Oxford University Press, International 3rd edition, 2016.
2) Iliffe, C.J., *Datums and Map Projections for Remote Sensing, GIS and Surveying*,Whittles Publishing, 2006.
3) Lillesand, M. and Kiefer., *Remote Sensing and Image Interpretation*, John Wileyand Sons, Inc., 2000

v) COURSE PLAN

Module	Contents	No. of hours
I	Basic concepts of GIS ,history of GIS, components of GIS-Geospatial Data, Attribute data, GIS operations, application of GIS, popular GIS Softwares. Geographic co-ordinate system, Map projections, commonly used map projections, projected co-ordinatesystem, georeferencing, geometric transformations.	**12**
II	Data structure - vector data model, raster data model, Types of raster data, data inputs to GIS platform, metadata, vector to raster conversion, digitization. Geodatabase management, attribute data management. cartography and map making elements.	**12**
III	GIS Data Processing –Vector data Analysis- Buffering, Overlay-Point-in-Polygon, Line-in-polygon, Polygon-in-polygon, Distance measurement, Pattern analysis, Map manipulation, Network Analysis. Raster Data Analysis- Local operations, Neighbourhood operation, Zonal Operation, other raster data operations.	**12**
IV	Advanced Applications: Introduction to terrain mapping, DEM and TIN, terrain mapping techniques, slope and aspect, WebGIS. Data quality analysis – Sources of Error – Components of data quality.	**12**

V	Remote sensing: definition, basic principles, application of remote sensing in GIS. Global Positioning System (GPS) - GPS basic concepts, GPS segments-satellites & receivers, GPSapplications. Application of GPS data in GIS environment.	**12**
	Total hours	**60**

vi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

vii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30A	STRUCTURAL DYNAMICS	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to introduce the various types of estimation, specification writing, analysis of rate and various methods to determine the valuation of building. It enables the students to prepare the detailed estimate of various items of work related to civil engineering construction. This course trains the student to find out the valuation of building by various methods.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the basic terms and principles associated with structural dynamics.	Understand
CO 2	Model single and multi-degree freedom systems for dynamic analysis and develop equations of motion	Apply
CO 3	Estimate parameters of dynamic systems	Apply
CO 4	Perform dynamic analysis of single and multi degree freedom systems.	Apply
CO 5	Analyse and design vibration isolation systems.	Apply
CO 6	Develop equations of motion for dynamic analysis of beams and perform free vibration analysis of simply supported beam.	Apply

iv) SYLLABUS

Introduction – Parameters of dynamic system – D'Alembert's principle, Equation of motion of SDOF systems – undamped free vibration analysis. Damped free vibration analysis. Measurement of damping – Logarithmic decrement, Response to harmonic loading - steady state and transient states – steady sate amplitude, Dynamic magnification factor.

Response of SDOF systems to rectangular load, triangular load and half sine pulse. Impulse response function, Response to general loads-Duhamel's integral. Response of SDOF system to support motion, Vibration Isolation, transmissibility

Multi degree of freedom systems – Lumped mass systems, shear building frame, Equation of motion, free vibration analysis, Natural frequencies and mode shapes, orthogonality of normal modes.

Forced vibration analysis of multi degree of freedom systems – mode superposition method. Response of MDOF systems subjected to harmonic load. MDOF system subjected to support motion.

Introduction to earthquake analysis - Response spectrum. Response spectrum analysis of MDOF systems. Distributed parameter systems, Differential equation – beam flexure (elementary case), undamped free vibration analysis of simply supported beams.

v) TEXT BOOKS

1) Mario Paz, Structural Dynamics, CBS Publishers, New Delhi, India, 2001.
2) Mukhopadhyay M., Vibrations, Dynamics and Structural Systems, Taylor & Francis, London, 2000.

(b) OTHER REFERENCES

3) Clough R. W. and J. Penzien, Dynamics of Structures, McGraw Hill, 1993.
4) Chopra A. K., Dynamics of Structures- Theory and application to Earthquake Engineering, Pearson Education India, 2007.
5) Biggs J. M., Introduction to Structural Dynamics, McGraw-Hill Book Inc., New York, 1964.
6) J.W. Smith, Vibration of Structures, Chapman and Hall, London.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to structural dynamics and its importance in Civil Engineering. Dynamic Load, Parameters of dynamic system D'Alembers's principle, Equation of motion of SDOF system. Undamped free vibration analysis, concept of natural frequency Modeling systems as SDOF spring-mass model, estimation of stiffness, determination of natural frequency Free vibration response of undamped SDOF systems Damped free vibration analysis – concept of critical damping and damping ratio, underdamped and overdamped systems Free vibration response of damped SDOF systems – measurement of damping – logarithmic decrement. Response of damped SDOF systems to harmonic loading – transient state and steady state responses. Response of undamped SDOF systems to harmonic loading. Steady state amplitude, Dynamic magnification factor, concept of resonance, frequency response plot of SDOF systems.	12
II	Response of undamped and damped SDOF systems to rectangular load. Response of undamped and damped SDOF systems totriangular load. Response of undamped and damped SDOF systems to half sine pulse. Impulse response function for undamped and damped systems Response to general load – concept of Duhamel's integral. Response of undamped and damped SDOF systems to support motion. Vibration isolation – force and displacement isolation, Transmissibility ratio. Design of vibration isolation systems	12

III	Multi-degree of freedom (MDOF) systems- examples, Lumped mass systems, Shear building frames Modelling of MDOF systems,Equation of motion Undamped free vibration analysis, Natural frequencies and mode shapes, orthogonality of mode shapes Mode superposition method - Free vibration response of undamped MDOFsystems Mode superposition method -Free vibration response of damped MDOF systems, concept of modal damping.	**12**
IV	Forced vibration analysis - Mode superposition method. Response of MDOF systems subjected to harmonic load. Maximum modal responses and modal combination using SRSS rule. MDOF system subjected to support motion – Equation of motion. Response of shear building frames subjected to support acceleration - maximum floor response using SRSS rule. Concept of frequency response function (FRF) of MDOF systems.	**12**
V	Introduction to earthquake analysis, Response spectrum – concept, Development of response spectrum Response spectrum analysis of MDOF systems. Distributed parameter systems, Differential equation for beam flexure (elementary case) and its solution Undamped free vibration analysis of simply supported beam – natural frequencies and mode shapes Undamped free vibration analysis of beams with different boundary conditions (formulation only)	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30B	TRANSPORTATION SYSTEMS MANAGEMENT	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to impart awareness on transportation system management, TSM strategies, promotion of non-transport modes and advanced transit technologies.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Apply a transportation system management strategy based on TSM goal or objective.	Apply
CO 2	Explain methods to manage a transit system to improve its management efficiency.	Understand
CO 3	Explain measures for the promotion of non-transport modes for a transportation system based on a goal or objective.	Understand
CO 4	Assess the suitability of advanced transit technologies in a transportation system.	Apply

iv) SYLLABUS

System approach to Transportation Planning; The need for TSM, Long range verses TSM Planning TSM characteristics: TSM planning cycle, TSM strategies, Objectives and Philosophy; Relevance of TSM actions in Indian context. Measures for Improving vehicular flow – one-way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes Reducing Peak Period Traffic – Strategies for working hours, Congestion Pricing; Traffic calming measures

Public Transport: Preferential Treatment to high Occupancy Vehicles; Transit system operations, Service and characteristics, Transit Service Improvement Measures; Car Pooling; Transit Management Improvement Measure; Multi-Modal Coordination; Transit and Para transit integration.

Bus Route Network Planning and Management: Type of Bus Route Networks; Suitability for a given Urban Area; Types of routes – Corridor routes, activity routes and residential routes; Issues in route networks evaluation – number of route, length of route; Route alignment methods; service coverage and accessibility index.

Local area traffic management: Promotion of Non – motorised modes: Measures to promote; Pedestrianisation: Pedestrian facilities and management. Bicycle Transportation – advantages; Planning Bicycle Facilities Junction Treats for cycle tracks;LOS criteria for Pedestrian and bicycle Facilities.

Advanced Transit Technologies: Conventional and Unconventional Systems; Rapid Transportation System; New technologies – LRT, monorail, Automated Highways- Hovercraft; System Characteristics and Suitability.

v) (a) TEXT BOOKS

1) C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice- Hall India, 2003.
2) Transportation Demand Management (TDM) Encyclopedia, Victoria Transport Policy Institute Canada, 2006.

(b) OTHER REFERENCES

1) Transportation Engineering and Planning, by C. S. Papacostas and P. D. Prevedouros, PrenticeHall of India Private Limited, 2001
2) Roger P. Roess, William R.McShane & Elena S.Prassas, Traffic Engineering, PrenticeHall, 1990.

vi) COURSE PLAN

Module	Contents	No. of hours
I	System approach to Transportation Planning; The need for TSM, Long range verses TSM Planning TSM characteristics: TSM planning cycle, TSM strategies, Objectives and Philosophy; Relevance of TSM actions in Indian context. Measures for Improving vehicular flow – one-way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes- Reducing Peak Period Traffic Strategies for working hours, Congestion Pricing	**12**
II	Public Transport: Preferential Treatment to high Occupancy Vehicles; Transit system operations, Service and characteristics, Transit Service Improvement Measures; Car Pooling; Transit Management Improvement Measure; Multi-Modal Coordination; Transit and Para transit integration;	**12**
III	Bus Route Network Planning and Management: Type of Bus Route Networks; Suitability for a given Urban Area; Types of routes – Corridor routes, activity routes and residential routes; Issues in route networks evaluation – number of route, length of route; Route alignment methods; service coverage and accessibility index.	**12**
IV	Local area traffic management: Promotion of Non – motorised modes: Measures to promote; Pedestrianisation: Pedestrian facilities and management. IRC codes. Bicycle Transportation – advantages; Planning Bicycle Facilities Junction Treats for cycle tracks; IRC codes for bicycle facilities. LOS criteria for Pedestrian and bicycle Facilities.	**12**
V	Advanced Transit Technologies: low carbon vehicles; Automated Highways: System Characteristics and Suitability, Electric vehicles, Automated vehicles: Planning, infrastructure and implementation; issues. Rapid Transportation System; New technologies – LRT,	**12**

	monorail, Bus rapid transit system (BRTS), Rail rapid transit system (RRTS).	
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30C	GROUND WATER HYDROLOGY	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course course is to expose the students to the fundamental concepts of groundwater hydrology and its engineering applications. The course aim to impart the knowledge on the hydraulics of subsurface fluid flow, characteristics of porous media, well flow near aquifer boundaries, surface investigation of ground water, quality of ground water, artificial recharge and ground water flow modeling.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the occurrence and movement of ground water through porous media and apply Darcy's law to simple ground water flow problems	Understand
CO 2	Estimate the aquifer parameters using different methods	Apply
CO 3	Estimate drawdown in wells due to the effect of aquifer boundaries and thickness of aquifers	Apply
CO 4	Prepare detailed estimates of tanks, septic tanks and soak pits.	Apply
CO 5	Estimate sea water intrusion length and fresh water discharge into the sea	Apply
CO 6	Perform numerical modeling of ground water system	Apply

iv) SYLLABUS

Vertical distribution of groundwater- Types of geologic formations, Properties of aquiferrelated to storage and transmissivity of water, Darcy's law, Steady unidirectional flow- steady flow in a homogenous aquifer- aquifer with recharge- flow into infiltration galleries. (Problemsfrom unidirectional flow)

Partial differential equation governing unsteady groundwater flow- unsteady radial flow towards well. Evaluation of aquifer parameters by Theis, Jacob's and Chow's method. (Problems from evaluation of aquifer parameters)

Well flow near aquifer boundaries- Image well system. Method of images- Practical cases (Problems from method of images). Surface investigation of ground water- different methods electrical resistivity method, seismic refraction method- determination of aquifer thickness of horizontal aquifers (Problems from resistivity method, seismic refraction)

Quality of ground water- Graphical representations. Pollution of ground water- sources, distribution and evaluation of ground water pollution (Brief description only). Sea water intrusion- Ghyben-Herzberg equation, sea water-fresh water interface, length of intrusion, upconing, preventive measures.(Problems from sea water intrusion)

Artificial recharge of ground water-different techniques. Modelling of ground water flow governing equations of ground water flow and boundary conditions (basic ideas only), solution of partial differential equation of ground water flow for 1D steady ground water flow in homogenous aquifers (confined and unconfined) using finite difference method (uniform mesh interval only)

v) (a) TEXT BOOKS

1) D.K. Todd, “Ground Water Hydrology”, Wiley International Ed; Toppan &Company Ltd, Tokyo, 1995.
2) H.M. Raghunath, “Groundwater”, New Age International Publishers, New Delhi, 2007.
3) A.K. Rastogi, “Numerical Ground Water Hydrology”, Penram International Publishers, Mumbai

(b) OTHER REFERENCES

4) Karanth, “Ground Water Assessment, Development and Management” Tata McGraw Hill publishing company Ltd.
5) “Ground Water Manual”, A Water Resources Technical Publication.
6) S.P Garg, “Ground Water and tube wells”, Oxford &IBH Publishing Company.
7) Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, “ Irrigation and Water Power Engineering”, Laxmi Publications (P) Ltd. 2009
8) Herman Bouwer, “Ground Water Hydrology”, MC Graw Hill Kogakusha Ltd.
9) H.M. Raghunath, “Ground Water Hydrology”, Wiley Eastern Limited.
10) Neven Kresic, “Hydrogeology and Ground Water modeling”, CRC press, Taylor & Francis group, 2007.
11) Freeze and Cherry, “Ground Water”, Prentice Hall

vi) COURSE PLAN

Module	Contents	No. of hours
I	Vertical distribution of ground water-Types of geologic formations, Properties of aquifer related to storage and transmissivity of water, Darcy’s law, Steady unidirectional flow, Steady flow in a homogenous aquifer, Problems from unidirectional flow, Aquifer with recharge, Flow into infiltration galleries Problems	12
II	Partial differential equation governing unsteady ground water flow, Unsteady radial flow towards well, Evaluation of aquifer parameters- The is method Evaluation of aquifer parameters- Jacob’s method,	12

	Evaluation of aquifer parameters- Chow's method, Problems- Evaluation of aquifer parameters	
III	Well flow near aquifer boundaries, Image well system, Method of images –particular cases, Problems from method of images, Surface investigation of ground water, Electrical resistivity method, refraction method, Determination of aquifer thickness of horizontal aquifers, Problems- resistivity method, seismic refraction	**12**
IV	Quality of ground water –Graphical representations, Pollution of ground water-sources, Distribution and evaluation of ground water pollution Sea, Water intrusion-Ghyben-Herzberg equation, Seawater-fresh water interface Length of intrusion, Upconing , Sea water intrusion- preventive measures Problems- Sea water intrusion	**12**
V	Artificial recharge of ground water- different techniques Modelling of ground water flow Governing equations of ground water flow and boundary conditions Solution of partial differential equation of ground water flow for 1D steady ground water flow in homogenous aquifer using finite difference method	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30D	FINITE ELEMENT METHODS	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course deals with the study of the behavior of structures under dynamic loads. The course provides the basic concepts of structural dynamics and the theoretical background to perform dynamic analysis of structures. The course focuses on analysis of single and multi-degree of freedom systems. An introduction to continuous system is also included. The course also provides an introduction to earthquake analysis of structures.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the basic features of boundary value problems and methods to solve them	Understand
CO 2	Apply the fundamental concept of the finite element method and develop the ability to generate the governing FE equations for systems governed by partial differential equations.	Apply
CO 3	Apply the basic element types and shape functions so as to identify and choose suitable elements to solve a particular problem.	Apply
CO 4	Explain the concept of isoparametric elements and apply it for problems in structural engineering.	Understand
CO 5	Apply numerical integration procedures as a tool to solve mathematical models in FEM.	Apply

iv) SYLLABUS

Introduction - Boundary value problems; Introduction to approximate numerical solutions for solving differential equations.

Formulation techniques: Element equations using variational approach- Element equations using weighted residual approach - the axial element example.

Basic elements: Interpolation and shape functions – convergence requirements; CST, LST, bilinear rectangular elements, solid elements.

Isoparametric Formulation: coordinate mapping - One dimensional bar element; Two dimensional isoparametric elements - CST, LST, bilinear quadrilateral elements - Plain stress, plain strain problems.

Development of stiffness matrix for beam elements; Introduction to higher order elements; Introduction to axisymmetric elements. Numerical Integration: Gauss quadrature

v) (a) TEXT BOOKS

1) Desai, C.S., Elementary Finite Element Method, Prentice Hall of India.
2) Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India

(b) OTHER REFERENCES

3) Cook, R.D., Malkus, D. S., and Plesha, M. E., Concepts and Applications of Finite Element Analysis, John Wiley.
4) Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India.
5) Gallaghar, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
6) Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Publications.
7) Krishnamoorthy, C.S., Finite Element Analysis Theory and Programming, Tata McGraw Hill.
8) Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, McGraw Hill.

vi) COURSE PLAN

Module	Contents	No. of hours
I	General introduction – brief review of matrix methods, applications and versatility of FEM, Introduction to Boundary value problems; approximate numerical solutions for solving differential equations - Least squares method, Collocation method, Galerkin method - examples	**12**
II	Formulation techniques: Variational approach and weighted residual approach – initial concepts and differences, Element equations using variational approach, Element equations using weighted residual approach, The axial element example in detail	**12**
III	Basic elements: Interpolation and shape functions, Convergence requirements; CST element, LST, bilinear rectangular elements, solid elements.	**12**
IV	Isoparametric Formulation: coordinate mapping - One dimensional bar element, Two dimensional isoparametric elements – CST element, LST, bilinear quadrilateral elements - Plain stress, plain strain problems.	**12**
V	Development of stiffness matrix for beam elements, Introduction to higher order elements, Introduction to axisymmetric elements, Numerical Integration: Gauss quadrature	**12**

		Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30E	EARTH DAMS AND EARTH RETAINING STRUCTURES	VAC	4	0	0	4	2020

i) PRE-REQUISITE: CE1U30C GEOTECHNICAL ENGINEERING II

ii) COURSE OVERVIEW:

Goal of this course is to impart to the students, in-depth knowledge about the fundamentals of earth dams and Earth pressure theories. After this course, students will be able to analyze stability of earth dams and various types of retaining structures.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the fundamentals of earth dams	Understand
CO 2	Analyze slope stability of earth dams	Apply
CO 3	Explain the basic concepts & theories of Earth pressure	Apply
CO 4	Evaluate earth pressure for different types of retaining structures	Apply
CO 5	Explain the basic concepts of valuation in buildings.	Understand
CO 6	Design Rigid and Flexible Retaining Walls applying the earth pressure theories	Apply

iv) SYLLABUS

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

Construction techniques of earth dams – methods of construction - Quality control Instrumentation – measurement of pore pressures - Determination of phreatic line - Stability analysis – critical stability conditions - Desired values of factor of safety for different loading conditions of dam - Evaluation of stability by Swedish Slip Circle Method and sliding wedge method under critical conditions

Earth pressure theories – Rankine‘s and Coulomb’s earth pressure theories for cohesionless and cohesive backfills – Computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills - Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Numerical Problems - Computation of earth pressures by Trial wedge method –A mathematical approach for completely submerged and partly submerged backfills - Numerical Problems - Importance of capillarity tension in earth pressure

Graphical methods of earth pressure computation – trial wedge method for coulomb‘s and Rankine‘s conditions, for regular and irregular ground and wall conditions -Rebhan‘s construction for active pressure - Friction circle method - Logarithmic spiral method - Design of gravity retaining wall – cantilever retaining walls - Numerical Problems - Flexible retaining structure – type and methods of construction – design strength parameters

Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems - Anchored sheet piles – free earth method – fixed earth method – Rowe‘s moment reduction method - Stability of sheet piling - Diaphragm walls and coffer dams – types of diaphragm walls and their construction techniques in various soil types - Earth pressure on braced cuts and coffer dams – Design of coffer dams

v) (a) TEXT BOOKS

1) Tschebotarioff G P, Foundations, Retaining and earth structures, 2nd edition, Mcgraw Hill Pub., 1973

b) OTHER REFERENCES

2) Clayton, Milititsky and Woods, Earth Pressure And Earth-Retaining Structures, Taylor and Francis, 1996.
3) Huntington, Earth pressure on retaining walls, John Wiley and Sons, 1957
4) Prakash, Ranjan and Saran, Analysis and Design of Foundations and Retaining structures,SarithaPrakashan, Meerut, 1977
5) IS : 7894 – 1975, Indian Standard Code of Practice for Stability Analysis of Earth Dams

vi) COURSE PLAN

Module	Contents	No. of hours
I	Earth dams – types of dams Selection of type of dam based on material availability Foundation conditions and topography Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores Types and design of filters Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation	12
II	Construction techniques of earth dams – methods of construction Quality control Instrumentation – measurement of pore pressures Determination of phreatic line Stability analysis – critical stability conditions Desired values of factor of safety for different loading conditions of dam Evaluation of stability by Swedish Slip Circle Method and sliding wedge method under critical conditions	12
III	Earth pressure theories – Rankine‘s and Coulomb'searth pressure theories for cohesionless and cohesive backfills – Computation of	12

	earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Numerical Problems Computation of earth pressures by Trial wedge method – A mathematical approach for completely submerged and partly submerged backfills Numerical Problems Importance of capillarity tension in earth pressure	
IV	Graphical methods of earth pressure computation – trial wedge method for coulomb‘s and Rankine‘s conditions, for regular and irregular ground and wall conditions -Rebhan‘s construction for active pressure Friction circle method - Logarithmic spiral method Design of gravity retaining wall – cantilever retaining walls - Numerical Problems Flexible retaining structure – type and methods of construction – design strength parameters	**12**
V	Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems Anchored sheet piles – free earth method – fixed earth method – Rowe‘s moment reduction method Stability of sheet piling Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types Earth pressure on braced cuts and coffer dams – Design of coffer dams	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H30F	ENVIRONMENTAL POLLUTION MODELLING	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to introduce various approaches for environmental pollution modeling. Students will learn how to develop a verified and validated model. The mathematics behind various environmental pollution models with their uncertainties will be discussed.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the mathematical modelling approach	Understand
CO 2	Explain how to build a model to represent physical transport of pollutants in environment	Understand
CO 3	Identify pollution transport scenarios in water, air and noise environment	Apply
CO 4	Interpret the modelling results for decision support	Apply

iv) SYLLABUS

Role of models in environmental pollution studies- objectives of modelling-modelling principles types of models-classification of mathematical models-deterministic, stochastic, continuous, discreet, static, dynamic, linear and non-linear-model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty - distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma

Air pollution modelling: Transport and dispersion of air pollutants- estimating concentrations from point sources –Dispersion Modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability-box models- line source model-area source model-puff model

Water quality modeling: historical development of water quality models; rivers and streams water quality modelling– low flow analysis – pollutant transport-advection, diffusion and dispersion–– Modelling lake water quality-mass balance for well mixed lakes-models for dissolved oxygen; Streeter Phelps model- sediment transport modelling

Groundwater modelling: use of ground water models-ground water flow modeling-Darcy's lawground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditionsmass transport of solutes,advection diffusion equation,favorable conditions for contaminant transport modelling parameters and boundary conditions, seawater intrusion – basic concepts and modelling Ghyben–Herzberg formula-popular ground water models

Environmental noise - noise generation mechanisms- need for noise modelling- modelling inputs sound propagation factors- Equivalent Continuous Sound Pressure Level (Leq)-noise mapping methodology-modelling traffic noise-CoRTN and RLS90 models

v) (a) TEXT BOOKS

1) Gilbert M Masters Wendell P Ela, Introduction to Environmental Engineering & Science, Pearson,2013
2) Steven C. Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997.
3) Todd David Keith, Ground water Hydrology, Fourth edition, John Wiley and Sons, New York, 2004..
4) C.P Kumar, Ground water assessment and modelling, Createspace Independent Pub, 2015

(b) OTHER REFERENCES

5) Seinfeld and Pandis, Atmospheric chemistry and physics, Wiley 2016
6) Marcello Benedini, George Tsakiris, Water quality modelling for rivers and streams, Springer 2013
7) Mary Anderson William Woessner Randall Hunt, Applied ground water modelling, Academic Press, 2015
8) Enda Murphy Eoin King, Environmental Noise Pollution, Elsevier, 2014

vi) COURSE PLAN

Module	Contents	No. of hours
I	Role of models in environmental pollution studies objectives of modelling-modelling principles types of models-classification of mathematical models-deterministic, stochastic, continuous, discreet, static, dynamic, linear and non-linear model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty - distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma	**12**
II	Air pollution modelling: Transport and dispersion of air pollutants estimating concentrations from point sources – dispersion modelling-Gaussian Plume Model – determination of dispersion parameters, atmospheric stability box models- line source model-area source model puff model	**12**
III	Water quality modeling: historical development of water quality models Rivers and streams water quality modelling– low flow analysis	**12**

	– pollutant transport-advection, diffusion and dispersion Modelling lake water quality-mass balance for well mixed lakes models for dissolved oxygen; Streeter Phelps model- sediment transport modelling	
IV	Groundwater modelling: use of ground water models ground water flow modeling-Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions mass transport of solutes, advection dispersion equation, favorable conditions for contaminant transport-modelling parameters and boundary conditions seawater intrusion – basic concepts and modeling Ghyben–Herzberg formula, popular ground water models	**12**
V	Environmental noise - noise generation mechanisms need for noise modelling noise mapping methodology modelling inputs-sound propagation factors - Equivalent Continuous Sound Pressure Level (Leq)- modelling traffic noise-CoRTN and RLS90 models	**12**
	Total Hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course Project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H40A	MODERN CONSTRUCTION MATERIALS	VAC	4	0	0	4	2020

i) PRE-REQUISITE: CE1U30E CONSTRUCTION TECHNOLOGY AND MANAGEMENT

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the recent developments in the modern construction materials. It also deals with conventional construction materials and their modern use. The course also familiarizes students with the ability to identify and decide the materials most suited for construction, considering the durability, sustainability and economy.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Outline the suitable type of concrete for a specific construction	Understand
CO 2	Classify various structural materials for construction	Understand
CO 3	Choose suitable structural materials for buildings	Apply
CO 4	Identify sustainable materials for construction	Apply
CO 5	Select various smart materials suitable for structures.	Apply

iv) SYLLABUS

Special concretes, bricks and its different types and purposes, industrial products, conventional and modern waterproofing materials and insulating materials, sustainable construction materials, assessment of energy and introduction to life cycle assessment, neoprene and bridge bearing pads, smart intelligent material, shape memory alloys, case study of smart and intelligent materials.

v) (a) TEXT BOOKS

1. P. C. Varghese, Building Materials, Prentice-Hall India, 2nd edition, 2015.
2. Eds. J.M. Illston and P.L.J. Domone, Construction materials: Their nature and behaviour, 3rd edition, 2001.
3. J.F. Young, S. Mindess, The Science and Technology of Civil Engineering Materials, Prentice Hall, 1st edition, 1997
4. A.M. Neville, Properties of concrete, Pearson, 4th edition,2012
5. Shetty M. S, Concrete Technology, S. Chand & Co, 8th edition, 2021

(b) .REFERENCES

1. Ganapathy, C., Modern Construction Materials, Eswar Press, 1st edition, 2015.
2. Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice Hall Inc, 4th edition, 1998.
3. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc, 4th edition,1999.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Concrete - special concretes for specific purposes like lightweight concrete, ready mixed concrete, high strength concrete, high performance concrete, self compacting concrete, fibre reinforced concrete, polymer concrete, geopolymer concrete, textile reinforced concrete, ferrocement (brief description of composition, properties, and applications of the above).	**12**
II	Bricks, fly ash bricks - Stone; Stabilised mud blocks, soil - cement blocks, calcium silicate bricks, red mud - Wood, Industrial Products which can substitute wood ; particle board, fibre board, hard board, Glulam - Polymers; Fibre reinforced polymers - Metals; Steel ; Aluminium - Bituminous materials – Glass, glass reinforced gypsum – Plastics - jute fibre polymer composite (RFPC).	**12**
III	Properties and use of conventional and modern waterproofing materials, Conventional and modern insulating materials (thermal, sound and electrical insulating materials). Concept of polymer floor finishes, Paints, tiles, Acoustic Treatment, Dry walls, anchors	**12**
IV	Sustainable Construction Materials - Wood, bamboo, straw bales, earthen materials, glass cullet, copper slag, municipal incinerated bottom ash, recycled aggregates, recycled plastic products, sustainable concretes, bio composites, thatched roofing, linoleum flooring. Energy - Definition, Types of Unit Energy Values, Assessment of Energy. (brief discussion only) Introduction to Life Cycle Assessment (brief discussion only)	**12**
V	Types- Neoprene, Bridge pads, thermocole- Smart and Intelligent Materials, Special features:- Shape Memory Alloys (SMAs), Magneto strictive Materials, Piezoelectric Materials, Electrochromic materials, Green materials including biomaterials, biopolymers, bioplastics– Case studies showing the applications of smart and Intelligent Materials.	**12**
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1UH40B	SOIL DYNAMICS AND MACHINE FOUNDATIONS	VAC	4	0	0	4	2020

i) PRE-REQUISITE: CE1U30C GEOTECHNICAL ENGINEERING II

ii) COURSE OVERVIEW

Goal of this course is to provide in-depth knowledge about the concepts and theories of soil dynamics and machine foundation.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply theory of vibrations to determine the response of single degree of freedom system.	Apply
CO 2	Explain IS code procedures for determining the dynamic soil properties.	Apply
CO 3	Apply various methods to determine the response of machine foundations for various modes of vibrations.	Apply
CO 4	Design machine foundation for reciprocating and impact type of machines.	Apply
CO 5	Design of open trench as wave barriers as per codes of practices.	Apply

iv) SYLLABUS

Theory of vibrations - Dynamic soil properties - Analysis of Machine Foundations - Design of foundation for reciprocating machines - Design of foundation for Impact type machines - Vibration isolation for Machine Foundations

v) (a) TEXT BOOKS

1) Das B. M. and Ramana G.V., Principles of Soil Dynamics, Cengage Learning, 2nd Edition, 2011.
2) Kramer S.L., "Geotechnical Earthquake Engineering", Prentice Hall Inc., 2003.
3) Saran S., Soil Dynamics and Machine Foundations, Galgotia Publications Pvt Ltd, 1999.

(b) REFERENCES

1) Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010.
2) Venkatramaiah, Geotechnical Engg, Universities Press, 2000.
3) Richart F.E, Hall J.R., Woods R.D., "Vibrations of Soils and Foundations", Prentice Hall Inc., 1970.
4) Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.
5) Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Theory of vibrations:** Definitions, Single degree freedom system - Free vibration of a spring mass system. Free vibration with viscous damping- Critically damped system, Over damped system, Under damped system. Logarithmic decrement. Forced vibration with damping. Frequency dependent excitation. **Dynamic soil properties:** Definition and factors affecting. Determination of dynamic soil properties - Cross hole test, Cyclic plate load test, Block vibration test, Correlations of dynamic soil properties with SPT N value	12
II	**Analysis of Machine Foundations:** Modes of vibrations of a rigid foundation block. Linear Elastic Weightless Spring method of analysis for all modes of vibration- Numerical problems. Concept of elastic Half-space method of analysis.	12
III	**Design of foundation for reciprocating machines:** Design of foundations for reciprocating machines (IS method of Design) -design requirements and design procedure for block type foundation- Necessary data, design criteria, permissible amplitude.	12
IV	**Design of foundation for Impact type machines:** Design criteria and design procedure for block type foundation (IS method). Properties and requirements of cushion pad, Construction criteria of foundations for impact type of machines.	12
V	**Vibration isolation for Machine Foundations**: Choice of vibration isolation -IS Guidelines, Active and passive isolation, Transmissibility, Design of wave barriers (open trench), dynamic properties of vibration isolators- coil springs, rubber springs, cork pads, Design procedure for foundations on absorbers .	12
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H40C	ENVIRONMENTAL POLLUTION CONTROL TECHNIQUES	VAC	4	0	0	4	2020

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The course is designed to impart knowledge on the fundamental aspects of environmental pollution and its control techniques among students. It helps the learners to understand the sources of environmental pollution, characteristics of pollutants, waste treatment techniques and empower the learners to adopt appropriate strategies to control the environmental pollution.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the sources, effects and control methods of air pollutants	Understand
CO 2	Explain the sources, effects and treatment methods of water pollutants	Understand
CO 3	Identify appropriate method to manage and treat industrial wastewater	Apply
CO 4	Identify different practices adopted for solid waste management of a community	Apply
CO 5	Summarize the environmental protection laws and acts implemented in India to abate the environmental pollution	Understand

iv) SYLLABUS

Air pollution: Sources, Effects and Control of gaseous and particulate pollutants
Water Pollution: Sources, Effects,Physico-chemical and Biological Treatments
Industrial Pollution: Characteristics, Pretreatment of industrial wastes. Essential elements of an Environmental Management System (EMS)
Solid waste management: Type, Source and Management - Waste minimization strategies.
Administrative and Legislative control of environmental pollution

v) (a) TEXT BOOKS

1) Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., *Environmental Engineering*, McGraw Hill Education, 2017.
2) Rao, C.S., *Environmental Pollution Control Engineering*, New Age International (P) Ltd., Publishers, 3rd edition, 2018
3) Rao, M.N., & Rao, H.V.N., *Air Pollution*, Tata McGraw Hill Co. Ltd, Delhi, 2001

4) Garg, S.K., *Water Supply Engineering*, 33rd edition, Khanna publishers, 2010.
5) Garg, S.K., *Sewage Disposal and Air Pollution Engineering*, 39th edition, Khanna publishers, 2021

(b) REFERENCES

1) Nemerow, N.L., *Theories and practices of industrial waste treatment*, Addison-Wesley Publishing Co., Inc.
2) Rao, M.N., *Waste water treatment, Rational methods of design and Industrial practice*, Oxford & IBH Publishing Co. Pvt. Ltd, Bombay.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to environmental pollution. Air pollution – Sources – Primary pollutants, Secondary pollutants Criteria pollutants– Effects. Control of gaseous pollutants. Control of particulate pollutants Automobile pollution control, Air Pollution Mitigation Measures- Ambient air quality standards	12
II	Water pollution – Sources – Various Pollutants – Effects, Physico-chemical and Biological Treatment – Screening, Skimming, Sedimentation, Coagulation, Filtration, Trickling Filters, Activated sludge process. Oxidation ponds	13
III	Industrial Pollution - Characteristics of industrial wastes: physical, chemical and biological. Pre-treatment of industrial wastes: waste volume reduction, Waste strength reduction neutralization, Equalization and proportioning, High rate anaerobic methods (design not needed), Essential elements of an Environmental Management System (EMS)	12
IV	Solid waste management: Type and source of solid waste, characteristics, Collection, segregation, transportation and processing, Waste minimization strategies – Reduction - Recycling – Reuse, Disposal - composting, sanitary landfill, incineration, Hazardous Waste Treatment and Disposal, Biological and chemical treatment of hazardous wastes, Landfill disposal of hazardous waste, Bioremediation of hazardous waste disposal sites	13
V	Administrative and Legislative control of environmental pollution, Important Environmental rules and regulations, Environmental protection acts and rules, Environmental Management Plan, identification and mitigation of environmental impacts	10
	Total hours	**60**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

viii) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test (2 numbers)	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CE1H49A	MINI PROJECT	VAC	0	1	6	4	2020

i) COURSE OVERVIEW:

Mini Project Phase I:

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Civil Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department to a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include: Survey and study of published literature on the assigned topic;

- Preparing an Action Plan for conducting the investigation, including teamwork
- Working out a preliminary Approach to the Problem relating to the assigned topic
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility
- Preparing a Written Report on the Study conducted for presentation to the Department

ii) COURSE OUTCOMES

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

CO 1	Identify problems and propose solutions to them	Apply
CO 2	Develop work plan and liaison with the team in completing as per schedule	Apply
CO 3	Examine the proposed solutions by theoretical calculations and through experimental	Analyse
CO 4	Defend the ideas through presentations in oral and written form	Evaluate

iii) COURSE PLAN

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration. Students should identify a topic of interest in consultation with the

Faculty-in-charge of mini project/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carry out the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

iv) CONTINUOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Marks Awarded by the guide	:	15 marks
Project Report	:	10 marks
Evaluation by the Committee	:	40 marks

v) End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

(a) Demonstration	:	50 Marks
(b) Project report	:	10 Marks
(c) Viva voce	:	15 Marks