GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore – 641 013

Curriculum and Syllabi For

M.E. (ENVIRONMENTAL ENGINEERING) (Full Time)

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS GOVERNMENT COLLEGE OF TECHNOLOGY THADAGAM ROAD, COIMBATORE – 641 013

PHONE 0422 – 2433355 FAX: +91 0422 – 2433355

Email: gctcoe@gct.ac.in

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641 013

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind**.**

MISSION

- To achieve academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

GOVERNMENT COLLEGE OF TECHNOLOGY

COIMBATORE – 641 013

ENVIRONMENTAL ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

To transpire as a centre of excellence in research with sustainable development and to articulate professionals with pioneering vision.

MISSION

- To make the department of Environmental Engineering a renowned centre for research.
- To transmit strong basics and applied research to bring out novel solutions by technocrats to the community at large.
- To create a nodal centre for providing consulting services for the benefit of Industries and Society.

GOVERNMENT COLLEGE OF TECHNOLOGY

COIMBATORE – 641 013

ENVIRONMENTAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission

PEO 1: Graduates will achieve a high level of technical expertise in the subjects related to Environmental Engineering and also good in communication skills that help them to achieve and succeed in various positions.

PEO 2: Graduates will have a strong understanding in Environmental engineering principles to do doctorate programmes and to grab employment and entrepreneurship opportunities.

PEO3: Graduates will get interest on the learning processes and inculcate in them professional ethics, moral values and social concern.

GOVERNMENT COLLEGE OF TECHNOLOGY

COIMBATORE – 641 013

M.E. ENVIRONMENTAL ENGINEERING

PROGRAMME OUTCOMES (POs)

Students of the Environmental Engineering Programme should be in possession of the following at the time of their graduation

PO 1: Ability to apply research skills and provide sustainable solutions in the various fields of environmental engineering employing different methodologies and techniques.

PO 2: Ability to use the latest techniques advanced modern engineering skills, instrumentation and software packages necessary for environmental engineering practice.

PO 3: Ability to communicate effectively and to possess excellent report writing presentation and documentation skills.

PO 4: Ability to execute the multidisciplinary projects with global standards and in a sustainable manner.

PO 5: Ability to recognize ethical and professional responsibilities in providing engineering solutions considering it impact in global, economic, environmental, and societal contexts.

PO 6: Ability to recognize the significance of lifelong learning and to accommodate themselves to the changing trends as per the societal needs.

GOVERNMENT COLLEGE OF TECHNOLOGY

COIMBATORE – 641 013

ENVIRONMENTAL ENGINEERING

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to manage natural resources in a sustainable manner.

PSO2: An ability to excel in the core areas of Environmental such as Water supply Engineering, Wastewater Engineering, Air pollution management, Solid and hazardous waste management etc.

PSO3: An ability to execute excellence in solving the Environmental Engineering problems with consideration of public health, safety and welfare.

PSO4: An ability to adapt and develop themselves according to the developments in the field of Environmental Engineering.

Curriculum

CURRICULUM FOR CANDIDATES ADMITTED DURING 2022-2023 AND ONWARDS

TWO YEAR M.E PROGRAMME

ENVIRONMENTAL ENGINEERING

CHOICE BASED CREDIT SYSTEM-CURRICULUM

FIRST SEMESTER

S.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	23EEFCZ1	Research Methodology and IPR	FC	40	60	100	3	0	0	3
2.	23EEFCZ2	Applied Mathematics for Environmental Engineers	FC	40	60	100	3	0	0	3
3.	23EEPC01	Design of water and wastewater Transport Systems	PC	40	60	100	3	0	0	3
4.	23EEPC02	Design of Physico – Chemical Treatment Systems	PC	40	60	100	3	1	0	4
5.	23EEPC03	Solid Waste Management	PC	40	60	100	3	0	0	3
6.	23EEPEXX	Professional Elective I	PE	40	60	100	3	0	0	3
7	23EEACXX	Audit course I	AC	40	60	100	2	0	0	0
PRACTICAL										
8.	23EEPC04	Environmental Monitoring and Analysis Laboratory	PC	60	40	100	0	0	4	2
Total				**340**	**460**	**800**	**20**	**1**	**4**	**21**

SECOND SEMESTER

S.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	23EEPC05	Biological processes for wastewater treatment	PC	40	60	100	3	1	0	4
2.	23EEPC06	Industrial Wastewater Management	PC	40	60	100	3	0	0	3
3.	23EEPC07	Air Quality Management	PC	40	60	100	3	1	0	4
4	23EEPEXX	Professional Elective II	PE	40	60	100	3	0	0	3
5	23EEPEXX	Professional Elective III	PE	40	60	100	3	0	0	3
6	23EEACXX	Audit course II	AC	40	60	100	2	0	0	0
PRACTICAL										
7	23EEPC08	Environmental Process Laboratory	PC	60	40	100	0	0	4	2
8	23EEEE01	Mini project	EEC	40	60	100	0	0	4	2
Total				**340**	**460**	**800**	**17**	**2**	**8**	**21**

THIRD SEMESTER

S.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	23EEPEXX	Professional Elective IV	PE	40	60	100	3	0	0	3
2.	23$$OEXX	Open Elective	OE	40	60	100	3	0	0	3
PRACTICAL										
3.	23EEEE02	Internship/Industrial Training	EEC	100		100	-	-	**	2
4.	23EEEE03	Project Phase I	EEC	100	100	200	0	0	12	6
Total				**280**	**220**	**500**	**6**	**0**	**12**	**14**

** 4 Weeks Internship/Industrial training

FOURTH SEMESTER

S.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PRACTICAL										
1.	23EEEE04	Project Phase II	EEC	200	200	400	0	0	24	12
Total				**200**	**200**	**400**	**0**	**0**	**24**	**12**

TOTAL CREDITS: 68

LIST OF FOUNDATION COURSE FOR M.E. ENVIRONMENTAL ENGINEERING										
S.No	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**Hours/Week**			
							L	**T**	**P**	**C**
1.	23EEFCZ1	Research Methodology and IPR	FC	40	60	100	3	0	0	3
2.	23EEFCZ2	Applied Mathematics for Environmental Engineers	FC	40	60	100	3	0	0	3
LIST OF PROFESSIONAL CORE COURSE FOR M.E. ENVIRONMENTAL ENGINEERING										
S.No	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**Hours/Week**			
							L	**T**	**P**	**C**
1.	23EEPC01	Design of water and wastewater Transport Systems	PC	40	60	100	3	0	0	3
2.	23EEPC02	Design of Physico – Chemical Treatment Systems	PC	40	60	100	3	1	0	4
3.	23EEPC03	Solid Waste Management	PC	40	60	100	3	0	0	3
4.	23EEPC04	Environmental Monitoring and Analysis Laboratory	PC	60	40	100	0	0	4	2
5.	23EEPC05	Biological processes for wastewater treatment	PC	40	60	100	3	1	0	4
6.	23EEPC06	Industrial Wastewater Management	PC	40	60	100	3	0	0	3
7.	23EEPC07	Air Quality Management	PC	40	60	100	3	1	0	4
8.	23EEPC08	Environmental Process Laboratory	PC	60	40	100	0	0	4	2
LIST OF EMPLOYABILITY ENHANCEMENT COURSE FOR M.E. ENVIRONMENTAL ENGINEERING										
S.No	**Course Code**	**Course Title**	**Category**	**CA Marks**	**End Sem Marks**	**Total Marks**	**Hours/Week**			
							L	**T**	**P**	**C**
1.	23EEEE01	Mini project	EEC	40	60	100	0	0	4	2
2.	23EEEE02	Internship/Industrial Training	EEC	100	----	100	-	-	**	2
3.	23EEEE03	Project Phase I	EEC	100	100	200	0	0	12	6
4.	23EEEE04	Project Phase II	EEC	200	200	400	0	0	24	12

** 4 Weeks Internship/Industrial training

LIST OF PROFESSIONAL ELECTIVES FOR M.E. ENVIRONMENTAL ENGINEERING

S.No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23EEPE01	Sustainable Environmental Management	PE	40	60	100	3	0	0	3
2	23EEPE02	Environmental Implications of Engineered Nanomaterial	PE	40	60	100	3	0	0	3
3	23EEPE03	Environmental Engineering Structures	PE	40	60	100	3	0	0	3
4	23EEPE04	Ground Water Contamination and Transport Modeling	PE	40	60	100	3	0	0	3
5	23EEPE05	Environmental Impact Assessment	PE	40	60	100	3	0	0	3
6	23EEPE06	Environmental Economics	PE	40	60	100	3	0	0	3
7	23EEPE07	Computing Techniques in Environmental Engineering	PE	40	60	100	3	0	0	3
8	23EEPE08	Environmental Risk Assessment	PE	40	60	100	3	0	0	3
9	23EEPE09	Environmental Management Standards	PE	40	60	100	3	0	0	3
10	23EEPE10	Air Quality Modeling	PE	40	60	100	3	0	0	3
11	23EEPE11	Environmental System Analysis	PE	40	60	100	3	0	0	3
12	23EEPE12	Remote Sensing and GIS Applications in Environmental Engineering	PE	40	60	100	3	0	0	3
13	23EEPE13	Soil Pollution Control	PE	40	60	100	3	0	0	3
14	23EEPE14	Hazardous Waste Management	PE	40	60	100	3	0	0	3
15	23EEPE15	Advanced Wastewater Treatment and Reuse	PE	40	60	100	3	0	0	3
16	23EEPE16	Environmental Biotechnology	PE	40	60	100	3	0	0	3
17	23EEPE17	Marine Pollution and Control	PE	40	60	100	3	0	0	3
18	23EEPE18	Geo – Environmental Engineering	PE	40	60	100	3	0	0	3
19	23EEPE19	Membrane Separation Processes for water and wastewater Treatment	PE	40	60	100	3	0	0	3
20	23EEPE20	Environmental Policy and Legislation	PE	40	60	100	3	0	0	3
21	23EEPE21	Instrumentation, Selection and Management of Environmental Engineering Equipments	PE	40	60	100	3	0	0	3
22	23EEPE22	Environmental Chemistry and Microbiology	PE	40	60	100	3	0	0	3

LIST OF OPEN ELECTIVES FOR M.E. ENVIRONMENTAL ENGINEERING

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	Building Bye-Laws and Codes of Practice	OE	40	60	100	3	0	0	3
2	23SEOE02	Planning of Smart Cities	OE	40	60	100	3	0	0	3
3	23SEOE03	Green Building	OE	40	60	100	3	0	0	3
4	23EEOE04	Environment Health and Safety Management	OE	40	60	100	3	0	0	3
5	23EEOE05	Climate Change and Adaptation	OE	40	60	100	3	0	0	3
6	23EEOE06	Waste to Energy	OE	40	60	100	3	0	0	3
7	23GEOE07	Energy in Built Environment	OE	40	60	100	3	0	0	3
8	23GEOE08	Earth and Its Environment	OE	40	60	100	3	0	0	3
9	23GEOE09	Natural Hazards and Mitigation	OE	40	60	100	3	0	0	3
10	23EDOE10	Business Analytics	OE	40	60	100	3	0	0	3
11	23EDOE11	Introduction to Industrial safety	OE	40	60	100	3	0	0	3
12	23EDOE12	Operations Research	OE	40	60	100	3	0	0	3
13	23MFOE13	Occupational Health and Safety	OE	40	60	100	3	0	0	3
14	23MFOE14	Cost Management of Engineering Projects	OE	40	60	100	3	0	0	3
15	23MFOE15	Composite Materials	OE	40	60	100	3	0	0	3
16	23TEOE16	Global Warming Science	OE	40	60	100	3	0	0	3
17	23TEOE17	Introduction to Nano Electronics	OE	40	60	100	3	0	0	3
18	23TEOE18	Green Supply Chain Management	OE	40	60	100	3	0	0	3
19	23PSOE19	Distribution Automation System	OE	40	60	100	3	0	0	3
20	23PSOE20	Electricity Trading & Electricity Acts	OE	40	60	100	3	0	0	3
21	23PSOE21	Modern Automotive Systems	OE	40	60	100	3	0	0	3
22	23PEOE22	Virtual Instrumentation	OE	40	60	100	3	0	0	3
23	23PEOE23	Energy Management Systems	OE	40	60	100	3	0	0	3
24	23PEOE24	Advanced Energy Storage Technology	OE	40	60	100	3	0	0	3
25	23AEOE25	Design of Digital Systems	OE	40	60	100	3	0	0	3
26	23AEOE26	Basics of Nano Electronics	OE	40	60	100	3	0	0	3
27	23AEOE27	Advanced Processor	OE	40	60	100	3	0	0	3
28	23VLOE28	HDL Programming Languages	OE	40	60	100	3	0	0	3
29	23VLOE29	CMOS VLSI Design	OE	40	60	100	3	0	0	3
30	23VLOE30	High Level Synthesis	OE	40	60	100	3	0	0	3
31	23CSOE31	Artificial Intelligence	OE	40	60	100	3	0	0	3
32	23CSOE32	Computer Network Management	OE	40	60	100	3	0	0	3
33	23CSOE33	Block Chain Technologies	OE	40	60	100	3	0	0	3

LIST OF AUDIT COURCES (AC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem. Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23EEACZ1	English for Research Paper writing	AC	40	60	100	2	0	0	0
2	23EEACZ2	Disaster Management	AC	40	60	100	2	0	0	0
3	23EEACZ3	Value Education	AC	40	60	100	2	0	0	0
4	23EEACZ4	Constitution of India	AC	40	60	100	2	0	0	0
5	23EEACZ5	Pedagogy Studies	AC	40	60	100	2	0	0	0
6	23EEACZ6	Stress Management by Yoga	AC	40	60	100	2	0	0	0
7	23EEACZ7	Personality Development Through life enlightenment skills	AC	40	60	100	2	0	0	0
8	23EEACZ8	Sanskrit for Technical Knowledge	AC	40	60	100	2	0	0	0

CURRICULUM DESIGN

S. No	Course Work Subject Area	No of Credits					Percentage
		I	II	III	IV	Total	
1.	Foundation Course	6	0	0	0	06	8.82 %
2.	Professional Cores	12	13	0	0	25	36.76 %
3.	Professional Electives	3	6	3	0	12	17.65 %
4.	Employability Enhancement Courses	0	2	8	12	22	32.35 %
5.	Open Elective Courses	0	0	3	0	03	4.41 %
Total Credits		**21**	**21**	**14**	**12**	**68**	**100%**

Syllabus

23EEFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	0	0	3

Course Objectives	• To impart knowledge on research methodology, Quantitative methods for problem solving, data interpretation and report writing. • To know the importance of IPR and patent rights.

UNIT – I	INTRODUCTION	9 Periods

Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.

UNIT – II	QUANTITATIVE METHODS FOR PROBLEM SOLVING	9 Periods

Statistical Modeling and Analysis, Time Series Analysis Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.

UNIT – III	DATA DESCRIPTION AND REPORT WRITING	9 Periods

Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables, Relation between frequency distributions and other graphs, preparing data for analysis.

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.

UNIT – IV	INTELLECTUAL PROPERTY	9 Periods

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – V	PATENT RIGHTS	9 Periods

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	*Stuart Melville and Wayne Goddard, "**Research methodology: an introduction**", Juta Academic, 2nd edition, 2014.*
2	*Donald H.McBurney and Theresa White, "**Research Methods**", 9th Edition, CengageLearning, 2013*
3	*RanjitKumar, "**Research Methodology: A Step by Step Guide for Beginners**", 5th Edition, 2019*
4	*Dr. C. R. Kothari and GauravGarg, "**Research Methodology: Methods and Trends**", New age international publishers, 4th Edition, 2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Formulate research question for conducting research.	K3
CO2	Analyze qualitative and quantitative data.	K4
CO3	Interpret research findings and give appropriate conclusions.	K2
CO4	Develop a structured content to write technical report.	K3
CO5	Summarize the importance of IPR and protect their research work through intellectual property.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	-	2	1
CO2	1	-	3	-	2	1
CO3	-	-	2	2	3	1
CO4	-	-	2	-	2	1
CO5	2	-	3	2	1	1
23EEFCZ1	2	1	3	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	30	10	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	30	10	10	-	100
ESE	25	35	20	10	5	5	100

23EEFCZ2	APPLIED MATHEMATICS FOR ENVIRONMENTAL ENGINEERS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	0	0	3

Course Objectives	• Understand the numerical solutions to algebraic, exponential, logarithmic and linear system of equations • Understand the random variables and corresponding probability distribution like Binomial, Poisson and Geometric for discrete random variable and Uniform, exponential and normal distribution for continuous random variables. • Understand test of hypothesis for both small and large samples based on normal distribution and evaluate control limits using control charts to examine whether the product is within control. • Understand the basic principles and methods of statistical design of experiments. The significances of effects of various factors on a given response are determined under uncertainty using statistical principles • Understand multivariate correlation analysis and forming Regression plane.

UNIT – I	**NUMERICAL METHODS**	**9 Periods**

System of Linear Equations: Gauss elimination, Gauss Jordan and Gauss Seidal method- matrix inversion by Gauss Jordan Method- Nonlinear equations: Regula Falsi and Newton Raphson Methods- Interpolation: Newton's and Lagrange's interpolation methods.

UNIT – II	**RANDOM VARIABLES & PROBABILITY DISTRIBUTIONS**	**9 Periods**

Random variables–Moments–Moment generating functions and their properties- Probability distributions: Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT – III	**TEST OF HYPOTHESIS**	**9 Periods**

Large samples: Tests for Means, Variances and Proportions – Small samples: Tests for Means, Variances and Attributes using t, F, Chi square distributions – Goodness of fit using Chi Square distribution.

UNIT – IV	**DESIGN OF EXPERIMENT**	**9 Periods**

Analysis of variance: Completely randomized design – Randomized block design – Latin square design.

UNIT – V	**STATISTICAL QUALITY CONTROL & CORRELATION ANALYSIS**	**9 Periods**

Statistical basis for Control charts – Control limits – Control charts of variables: $\bar{X}$ & R– charts, Control chart of attributes: p, np charts, c chart - Correlation –Regression – Multiple and Partial Correlation.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	Miller and Freund **"*Probability and Statistics for Engineers*",** Prentice Hall of India Ltd, New Delhi 2015
2	S. C. Gupta and V. K. Kapoor**, "*Fundamental Statistics*"**, Sulthan Chand & Sons, New Delhi –Reprint-2018.
3	S. P. Gupta**, "*Statistical Methods",*** Sulthan Chand & Sons, New Delhi – 46th Edition, 2021.
4	Richard A.Johnson and Dean W.Wichern, **"*Applied Multivariate Statistical Analysis*",** Pearson Education, Asia, 6th Edition, 2012.
5	Jay L.Devore, **"*Probability and statistics for Engineering and the Sciences*",** 8th Edition, Thomson and Duxbury, Singapore, 2012
6	Dr. P. Kandasamy, Dr. K. Thilagavathy, Dr. K. Gunavathy, **"*Numerical Methods",*** S.Chand and sons, Ram Nagar, New Delhi, 2010.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve algebraic, exponential, logarithmic, and linear systems of equations numerically.	K3
CO2	Examine the random variables and corresponding probability distribution of discrete and continuous one-dimension random variables.	K3
CO3	Analyze the hypothesis for both small and large samples based on normal distribution and evaluate control limits using control charts to examine whether the product is within control.	K3
CO4	Apply the basic principles and methods of statistical design of experiments. The significances of effects of various factors on a given response are determined under uncertainty using statistical principles	K3
CO5	Perform the multivariate correlation analysis and forming Regression plane.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	-	-	-
CO2	3	2	1	-	-	-
CO3	3	3	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	2	3	-	-	-
23EEFCZ2	3	3	3	-	-	-
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	30	10	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	30	10	10	-	100
ESE	25	35	20	10	5	5	100

23EEPC01	DESIGN OF WATER AND WASTEWATER TRANSPORT SYSTEMS					SEMESTER I
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PC**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on general hydraulics, water transmission, wastewater conveyance, storm water drainage and respective software applications.					
UNIT – I	**GENERAL HYDRAULICS AND FLOW MEASUREMENT**					**9 Periods**
Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor head losses; Carrying Capacity; Flow measurement.						
UNIT – II	**WATER TRANSMISSION AND DISTRIBUTION**					**9 Periods**
Planning of Water transport System –Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics- economics; Specials, Joints, laying and maintenance, water hammer analysis; water distribution pipe network design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses.						
UNIT – III	**STORM WATER DRAINAGE**					**9 Periods**
Estimation of storm water run-off Formulation of rainfall intensity duration and frequency relationships-Rational methods; Necessity and design of combined and separate system.						
UNIT – IV	**WASTEWATER COLLECTION AND CONVEYANCE**					**9 Periods**
Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.						
UNIT – V	**SOFTWARE APPLICATIONS**					**9 Periods**
Use of computer software in water transmission, water distribution and sewer design – EPANET 2.2, LOOP version 4.0, SEWER, BRANCH and GIS based softwares.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	***"Hydraulics and Fluid Mechanics Including Hydraulics Machines",*** *P.N.Modi and S.M.Seth, Standard Book House, 2018.*
2	***"Manual on water supply and Treatment",*** *CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.*
3	***"Manual on Sewerage and Sewage Treatment",*** *CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.*
4	***"Water supply engineering" and "Sewage waste disposal and air pollution engineering" (VOL 1 & 2), S.K. GARG, Khanna Publishers, 2010 & 2018.***

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply fluid flow principles in pipe flow calculations	K3
CO2	Analyze and design water transmission and distribution systems	K4
CO3	Estimate the storm water and design the combined and separate systems	K4
CO4	Select pipe materials for wastewater conveyance and design the wastewater pumps	K4
CO5	Illustrate and design the water and wastewater transport systems by applying the software	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	1	-	-	1
CO2	3	2	1	-	-	1
CO3	3	2	1	-	-	1
CO4	3	2	1	-	-	1
CO5	2	2	1	-	-	1
23EEPC01	3	2	1	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	30	10	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	30	10	10	-	100
ESE	25	35	20	10	5	5	100

23EEPC02	DESIGN OF PHYSICO – CHEMICAL TREATMENT SYSTEMS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course objectives	Understanding the qualification and characterisation of water and waste water for the design of Conventional treatment units and exploring the advanced treatment methods to be adopted.

UNIT – I	INTRODUCTION	9+3 Periods

Quality of water and wastewater – Characteristics and Examination of water and wastewater – water quality and effluent standards – Water Quality Indices - Significance of Physico-chemical treatment - Water purification in Natural systems; Primary, Secondary and Tertiary Treatment.

UNIT – II	TREATMENT PRINCIPLES	9+3 Periods

Basics principles of Physical treatment – Screening, Flow Equalization, Mixing and Flocculation, Gravity Separation theory, Grit Removal, Primary Sedimentation, Clarification, Flotation, Oxygen Transfer, Aerations Systems, Removal of Volatile Organic compounds (VOCs) by aeration – Adsorption isotherms – Membrane separation, reverse Osmosis, Nano filtration, Ultra Filtration and Hyper filtration. Basic principles of Chemical Treatment - Coagulation, Flocculation, Precipitation, Solidification and stabilization, Disinfection, Ion exchange, Electrolytic methods, Solvent extraction, Advanced oxidation/reduction.

UNIT – III	DESIGN OF CONVENTIONAL WATER TREATMENT PLANTS	9+3 Periods

Objectives of conventional water treatment units – Design of screens, chemical feeding, flocculator, clarifier, tube settlers, Filters – rapid, slow and pressure filters- Disinfection units. Flow charts – Layouts – Hydraulic profile – Operation and Maintenance aspects – Residue management – Recent advances in upgrading existing plants – case studies.

UNIT – IV	DESIGN OF CONVENTIONAL SEWAGE TREATMENT PLANTS	9+3 Periods

Objectives of conventional sewage treatment units – Flow charts – Design of bar rack, deteritors, oil skimmers - grit chamber with proportional flow weir, settling tanks, settling tanks, Equalization, Neutralization, Chemical feeding devices – flotation units. Layout and Hydraulic profile, operation and maintenance aspects – Residue management - – Recent advances in upgrading existing plants – case studies.

UNIT – V	DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS	9+3 Periods

Objectives, principles and Typical flow charts – Design of sludge thickeners, low rate and high rate digesters, sludge dewatering systems, and sludge drying beds. Design of softeners, mineralizers and desalination plants, membrane technologies and RO process. Residue management- operation and maintenance – Requirement of water for industrial applications.

Contact Periods:

Lecture:45 Periods **Tutorial: 15 Periods** **Practical: 00 Periods** **Total: 60 Periods**

REFERENCES

1	***"Physicochemical processes for water quality control"**, Weber, W.J., John Wiley and sons, New York, 1983*
2	***"Wastewater Engineering, Treatment and Reuse"**, Metcalf and Eddy, Tata McGraw Hill, New Delhi, 2003.*
3	***"Wastewater Treatment: Concepts and Design Approach",** Karia, G.L., and Christian, R.A.,Prentice-Hall of India Pvt., Ltd., New Delhi, 2013.*
4	***"Manual on Sewerage and Sewage Treatment"**, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013.*
5	***"Environmental engineering"** Peavy, H. S., Rowe, D. R., Tchobanoglous, McGraw hills, New York, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Evaluate the water and wastewater quality and environmental significance of various parameters.	K3
CO2	Execute the principles and operation of various treatment units.	K3
CO3	Appraise the suitability of the design of water and wastewater treatment plants and unit processes.	K3
CO4	Evaluate the operation and performance of water and wastewater treatment units.	K3
CO5	Implement the treatment mechanisms for different industrial effluents.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	2	1
CO2	3	3	2	2	2	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	2	1
CO5	3	3	2	2	3	1
23EEPC02	3	3	2	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	30	10	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	30	10	10	-	100
ESE	25	35	20	10	5	5	100

23EEPC03	SOLID WASTE MANAGEMENT	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand, characterize and process solid waste with a particular focus on methods for recovery and knowledge on sanitary landfill.

UNIT – I	SOLID WASTE GENERATION AND MANAGEMENT SYSTEM	9 Periods

Definition of solid wastes- Sources and types of municipal solid wastes- Generation rate- Factors affecting generation rates- characteristics- methods of sampling and characterization- Effects of improper disposal of solid wastes public health and environmental effects- Solid Waste Management- Goals and objectives- Functional Elements in a Solid Waste Management- Municipal Solid Waste (M&H) rules 2016

UNIT – II	SEGREGATION, STORAGE, COLLECTION AND TRANSPORTATION	9 Periods

Segregation and storage of solid waste at source - Onsite handling - collection systems and services, vehicles and equipment for collection - Factors affecting collection - community involvement and role of informal sector in waste collection- transfer stations – types of transport and location of transfer stations.

UNIT – III	RECYCLING AND RECOVERY	9 Periods

Processing Techniques - Advantages of recycling, important recycling materials - stages of material recovery in solid waste management chain – principle of unit operations and equipments employed at material recovery facilities – Composting - Aerobic and anaerobic composting, benefits of composting, factors affecting composting process, windrow, aerated static pile, in-vessel and decentralized composting technologies, vermicomposting.

UNIT – IV	WASTE TO ENERGY	9 Periods

Energy recovery potential, basic techniques of energy recovery; incineration – process 3Ts, incinerator details, prevention of air pollution; pyrolysis - process description, various operations involved, end products; biomethanation; refuse derived fuels, gasification.

UNIT – V	SANITARY LAND FILLING	9 Periods

Definitions, types of wastes to be accepted at landfills, site selection, essential components of municipal sanitary landfill, landfilling methods, sanitary landfill design, leachate management, active and passive control of landfill gases.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"CPHEEO (2016) Municipal Solid Waste Management Manual,"**, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi.*
2	***"Health Monitoring of Structural Materials and Components Methods with Applications"**, Tchobanoglous G., Theisen H., Vigil S.A. 2nd Ed., McGraw-Hill, USA (2014).*
3	***"Environmental Engineering",** Peavy, H.S., Rowe, D.R., and Tchobanoglous, G. 1st Ed., McGraw Hill Education,USA (2017).*
4	***"Hand Book of Solid Waste Management",** Tchobanoglous G., Frank Kreith, 2nd Ed., McGraw Hill, USA (2002).*
5	***"Geotechnical Aspects of Landfill Design and Construction"**, Qian X, Koerner RM and Gray DH.,1st Ed., Prentice Hall, USA(2002*
6	***"Solid waste management: Collection, Processing and Disposal"** Bhide, A D and Sundaresan, B B NEERI, Nagpur. (2001)*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the different elements of solid waste management	K2
CO2	Differentiate the concepts of segregation, storage, collection and transportation of solid waste	K3
CO3	Investigate the important concepts of processing techniques and energy recovery	K3
CO4	Implement the concept of energy recovery from waste to wealth	K3
CO5	Apply the knowledge of sanitary landfilling	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	2	2	1
CO2	3	3	-	2	3	1
CO3	3	3	-	3	3	1
CO4	3	3	-	3	3	1
CO5	3	3	-	3	3	1
23EEPC03	3	3	-	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEPC04	ENVIRONMENTAL MONITORING AND ANALYSIS LABORATORY	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	To determining the quality characteristics of water, wastewater, air and noise.

LAB EXPERIMENTS / PROGRAMS

I. WATER AND WASTEWATER:

1. Determination of pH, Solids (TDS, TSS, VS), Acidity, Alkalinity, Hardness, Chlorides and Fluorides
2. Determination of Dissolved Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand
3. Estimation of Nitrogen, Phosphates and Sulphates
4. Determination of Available Chlorine in bleaching powder and Break point Chlorination test
5. Plate count test and MPN test
6. Estimation of Organic Compounds Using HPLC and TOC
7. Determination of Heavy metals using AAS

II. AIR :

8. Estimation of Particulate matter (PM_{10}, $PM_{2.5}$), SOx, NOx and VOC in ambient air
9. Estimation of VOC and CO in Indoor air

III. NOISE:

10. Estimation of ambient Noise level

IV. ADVANCED INSTRUMENT TECHNIQUES:

11. Analysis of Environmental Engineering problems using advanced instruments

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the various physical and chemical characteristics of water and wastewater.	K4
CO2	Analyze the various biological characteristics of water and wastewater.	K4
CO3	Identify the heavy metal present in the wastewater.	K4
CO4	Measure the air and noise pollution in outdoor and indoor environment	K4
CO5	Analyze Environmental problems using advanced instrument.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	2	2	2	1
CO3	3	3	2	2	2	1
CO4	3	3	2	2	2	1
CO5	3	3	2	2	2	1
23EEPC04	3	3	2	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
Exercise 1	10	15	25	25	20	5	100
Exercise 2	10	15	25	20	25	5	100
Exercise 3	10	15	25	25	20	5	100
Exercise 4	10	15	25	25	20	5	100
Exercise 5	15	15	25	25	15	5	100
Exercise 6	10	15	25	25	20	5	100
Exercise 7	10	10	30	25	20	5	100
Exercise 8	10	15	25	25	20	5	100
Exercise 9	10	15	25	25	20	5	100
Exercise 10	10	15	25	25	20	5	100
Exercise 11	10	25	25	25	10	5	100
Model Lab	10	15	25	20	25	5	100
Other mode of internal assessments	-	-	-	-	-	-	-
ESE	10	10	30	25	20	5	100

23EEPC05	BIOLOGICAL PROCESS FOR WASTEWATER TREATMENT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	Imparting the principles and applications of biological processes in wastewater treatment.

UNIT – I	INTRODUCTION, PROCESS ANALYSIS AND SELECTION	9+3 Periods

Biological treatment processes – objectives – Choice of treatment method – Environmental impact and other considerations in planning the treatment – Cost of Wastewater treatment – Reactors used for the treatment – mass balance analysis – Reactions, Reaction rates – Enzyme reaction. Modeling of ideal flow and non-ideal flow reactors – Reactors in parallel – Reactors in series – Tracer tests – Estimation of dispersion coefficient.

UNIT – II	SUSPENDED GROWTH TREATMENT PROCESS- ASP	9+3 Periods

Role of microorganisms – Microbial growth kinetics – Biological oxidation process – loading -MCRT – F/M ratio – Determination of biokinetic coefficients – Modeling of suspended growth treatment process – Description, Design and operating parameters – Modeling of plug flow reactors – Oxygen requirements- arrangement for transfer of oxygen- Secondary clarifier- design features.

UNIT – III	SUSPENDED GROWTH TREATMENT PROCESS	9+3 Periods

Aerated lagoons. Oxidation pond – Stabilization ponds – Classification – Application – Process design, flow pattern and analysis of Aerobic ponds – Facultative ponds – Anaerobic ponds – maturation ponds – Construction and performance – MBBR systems.

UNIT – IV	ATTACHED GROWTH TREATMENT PROCESS	9+3 Periods

Attached Growth Treatment Process – Substrate Removal in Attached Growth Treatment Process - Trickling Filter – Process – Classification - design based on Popular design equations – NRC, Rankine's and Eckenfelder equation – Rotating Biological contactors – Anaerobic attached growth treatment processes – upflow packed Bed – upflow expanded bed – Fluidized bed – Down flow bed. (Only theory).

UNIT – V	SUSPENDED GROWTH TREATMENT PROCESS- DIGESTION PROCESS	9+3 Periods

Sludge digestion- Sources of sludge- Characteristics- Quantities- Anaerobic digestion- Process- Kinetic relationship- gas production- design considerations. Anaerobic treatment of liquid wastes- Anaerobic sludge blanket process- design considerations. Sludge management facilities, sludge thickening, sludge dewatering (mechanical and gravity) layout.

Contact Periods:

Lecture: 45 Periods **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**

REFERENCES:

1	***"Waste Water Engineering – Treatment and reuse",*** *Metcalf and Eddy, Fourth Edition, McGraw Hill Education, 2017.*
2	***"Waste Water Treatment and disposal",*** *Arceivala S. J., Marceldekker publishers, 1981.*
3	***"Biological process design for Wastewater Treatment",*** *Larry D. Benefield and Clifford W. Randall, Ibis publishers, 1994.*
4	***"Environmental Engineering",*** *Howard S. Peavy, Donald R. Rowe and George Techobanoglous, McGraw Hill Education, 2017.*
5	**"Wastewater Treatment for Pollution Control and Reuse",** *Arceivala S. J., Third Edition, McGraw Hill Education, 2017*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the background of biological treatment processes.	K2
CO2	Model the suspended growth process.	K3
CO3	Analyze and Design the suspended growth treatment plant and ponds.	K3
CO4	Analyze and Design attached growth treatment process facilities.	K3
CO5	Examine the various digestion processes.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	2	2	-
CO2	3	3	2	3	2	-
CO3	3	2	3	3	2	-
CO4	3	2	2	2	3	-
CO5	3	3	2	2	2	-
23EEPC05	3	3	3	3	3	-
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	45	20	5	-	100
CAT2	10	20	45	20	5	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	10	20	45	20	5	-	100

23EEPC06	INDUSTRIAL WASTEWATER MANAGEMENT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	Analysing the disposal effects of industrial waste water with the help the principles of waste minimization techniques, and also imparting knowledge about pollution from major industries and treatment technologies.

UNIT – I	SOURCES AND ENVIRONMENTAL ASPECTS	9 Periods

Sources and types of industrial wastewater- Environmental Impacts-Industrial wastewater monitoring and sampling -characterization and variables - Toxicity and Bioassay tests. Prevention vs Control of Industrial Pollution- Source reduction techniques- effect of Industrial Effluents on Streams, Sewer and Human health.

UNIT – II	WASTE TREATMENT PRESPECTIVE	9 Periods

Waste minimization - Equalization - Neutralization -Oil separation -Flotation -Precipitation -Heavy metal Removal -Adsorption -Aerobic and anaerobic biological treatment – Sequencing batch reactors -High-Rate reactors - Chemical and wet air oxidation - Ozonation - Photocatalysis – ion exchange-membrane technologies - Nutrient removal.

UNIT – III	EFFLUENT DISPOSAL TECHNIQUES	9 Periods

Common Effluent Treatment Plants - Advantages - zero polluting industry concept - Reduce, Reuse and Recycle of wastewater-Disposal of effluent on land- characteristics and disposal of sludge – Residual Management.

UNIT – IV	INDUSTRIAL WASTEWATER TREATMENT- I	9 Periods

Industrial manufacturing process description, wastewater characteristics, source reduction points and effluent treatment flow sheet for Textiles – Tanneries - Sugar and distilleries – Petroleum refineries – Food processing - Fertilizers-Dairy - Pharmaceutical industry.

UNIT – V	INDUSTRIAL WASTEWATER TREATMENT- II	9 Periods

Industrial manufacturing process description, wastewater characteristics, source reduction points and effluent treatment flow sheet for, Pulp and Paper mill - Iron and Steel industries- Meat packing industries and Poultry Plant-Automobile Industry – Industrial Estates.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	***"Microbiology and Chemistry for Environmental Scientists and Engineers"****, J N Lester, Second edition,2018*
2	***"Chemistry for Environmental Engineering and Science"****, Clair N. Sawyer, Perry L. Mccarty & Gene F Parkin, McGraw Hill Education, Fifth edition, 2017*
3	***"Environmental Chemistry",*** *Anil Kumar De, Arnab Kumar De, New Age International publishers, Tenth edition, 2021.*
4	***"Environmental Science and Engineering",*** *Yugananth P &Kumaravelan R, Scitech Publications, Second edition, 2015.*
5	***"Manual of Environmental Microbiology",*** *Marylynn V Yates, Fourth edition, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy mapped
CO1	Outline the waste water sources and environmental implications of various industrial effluents.	K2
CO2	Summarize the various pollution prevention options.	K2
CO3	Assess the remedial technologies for disposal of industrial effluents.	K3
CO4	Employ the design solutions for the treatment and disposal of treated effluents.	K3
CO5	Implement and comprehend the pollution control methods for specific industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	2
CO2	3	2	3	2	2	3
CO3	3	3	2	2	2	1
CO4	3	3	2	3	2	2
CO5	3	2	3	2	2	3
23EEPC06	3	3	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / bloom's category*	**Remembering (k1) %**	**Understanding (k2) %**	**Applying (k3) %**	**Analyzing (k4) %**	**Evaluating (k5) %**	**Creating (k6) %**	**Total %**
CAT1	25	35	20	10	10	-	100
CAT2	25	35	20	10	10	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	10	-	100

23EEPC07	AIR QUALITY MANAGEMENT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	Identifying the different air pollutants sources, characteristics and adopting suitable sampling, modeling techniques along with control measures including indoor air quality management and their legislations.

UNIT – I	INTRODUCTION TO AIR POLLUTANTS	9 + 3 Periods

Atmosphere as a place of disposal of pollutants – Definition- Air Pollution – Air Pollutants – Source and classification of pollutants – Units of measurements of pollutants - Ambient air quality standards - Air pollution indices - Air pollution and its effects on human beings, plants and animals - Economic effects of air pollution

UNIT – II	SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING	9 + 3 Periods

Ambient air sampling and measurement of particulate and gaseous pollutants Environmental factors - Meteorology - temperature lapse rate and stability – Adiabatic lapse rate – Wind Rose - Inversion – Wind velocity and turbulence - Stack sampling - Plume behaviour - Dispersion of air pollutants - Maximum mixing depth - Dispersion model - Fixed Box models - Estimation of plume rise - Stack design.

UNIT – III	CONTROL OF PARTICULATE AND GASEOUS CONTAMINANTS	9 + 3 Periods

Factors affecting Selection of Control Equipment – Working principles of various types of particulate control equipment - Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Working principles of various types of gaseous control equipment - absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters Case studies for stationary and mobile sources.

UNIT – IV	INDOOR AIR QUALITY MANAGEMENT	9 + 3 Periods

Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control – Membrane process - UV photolysis – Health effects of indoor air pollution.

UNIT – V	AIR POLLUTION SURVEY, LEGISLATIONS AND CASE STUDIES	9 + 3 Periods

Air pollution survey - Air pollution legislation and regulations – Environmental criteria for siting industries and green belts - Air pollution in Indian cities. Case studies – some specific industries - cement industry - refineries - fertilizer - paper industry - Sources of pollutants and its controls - Cost benefit analysis.

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods

REFERENCES

1	***"Environmental Engineering",*** *Howard S. Peavy, Doald R. Rowe and George Tchobanoglous, McGraw-Hill Co.,2013*
2	***"Air Pollution and Control Technologies",*** *Dr. Y. Anjaneyulu, Allied publishers Ltd.,2nd edition,2018.*
3	***"Air Quality"*** *Thad Godish, Taylor and Francis, 5th edition, 2017.*
4	***"Air pollution prevention and control technologies",*** *Anjaneyulu yerramilli,2020*
5	***"Principles of Air Quality Management",*** *Roger D.Griffin, 2020.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Compare the status of global and local air pollution scenario and their effects	K2
CO2	Interpret the modeling and analysis of air pollutants.	K3
CO3	Implement the concepts of control strategies adopted for removal of particulate matter and gaseous pollutants	K3
CO4	Summarize the indoor air pollution sources and management.	K2
CO5	Apply the concepts of air pollution survey, legislation and case studies.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2	2	2
CO2	3	3	1	3	3	1
CO3	3	3	1	2	3	2
CO4	3	3	1	3	3	2
CO5	3	2	3	2	2	2
23EEPC07	3	3	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEPC08	ENVIRONMENTAL PROCESS LABORATORY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	To develop the skill for conducting treatability studies of water and wastewater treatment by various operation and processes using laboratory scale models and to ascertain the suitability of water sample for various purposes.

LAB EXPERIMENTS / PROGRAMS

1. Study on Jar test for determining optimum coagulant dosage.
2. Study on Electro Coagulation Process.
3. Batch Studies on settling
    a) Type – I Settling
    b) Type – II Settling
4. Determination of Characteristics of Filter media.
5. Adsorption studies
    a) Batch
    b) Continuous
6. Performance analysis of Aeration system.
7. Performance analysis of Activated Sludge Process
8. Advanced Oxidation Studies using Photo catalytic reactor
9. Casting and testing of membrane using membrane casting unit
10. Synthesis and characterization of Nano rods using Electro spinning techniques / CVD Chamber
11. Determination of organic compounds from waste compost

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Perform the coagulation process for wastewater treatment.	K3
CO2	Determine the batch settling data for wastewater	K3
CO3	Investigate the efficiency of colour removal by adsorption process	K3
CO4	Synthesis and characterize the nano materials for the wastewater treatment	K3
CO5	Identify the organic composition from the waste compost	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	2	2	3	2	3
CO3	3	2	2	2	2	3
CO4	3	3	3	2	2	3
CO5	3	2	2	2	2	3
23EEPC08	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
Exercise 1	20	25	25	15	10	5	100
Exercise 2	10	15	25	20	25	5	100
Exercise 3	10	15	25	25	20	5	100
Exercise 4	10	15	25	25	20	5	100
Exercise 5	15	15	25	25	15	5	100
Exercise 6	10	15	25	25	20	5	100
Exercise 7	10	10	30	25	20	5	100
Exercise 8	10	15	25	25	20	5	100
Exercise 9	10	15	25	25	20	5	100
Exercise 10	10	15	25	25	20	5	100
Exercise 11	10	25	25	25	10	5	100
Model Lab	10	15	25	20	25	5	100
Other mode of internal assessments	-	-	-	-	-	-	-
ESE	10	10	30	25	20	5	100

23EEEE01	MINI PROJECT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	4	2

Course Objectives	To Identify environmental engineering problems, review of literature, methodology, modelling and design of Prototypes by applying engineering principles.

SYLLABUS

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify Environmental Engineering problems based on the current scenario	K2
CO2	Familiarize with the various treatment process for water, wastewater, air pollution and solid waste.	K2
CO3	Apply different treatments and control systems for waste management.	K3
CO4	Encounter the analysis and design of entire process unit.	K4
CO5	Develop a suitable sustainable solution for environmental engineering problems.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2
23EEEE01	3	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	10	25	15	10	40	100
CAT2	-	10	25	15	10	40	100
Individual Assignment 1/ Case Study 1/ Seminar 1/ Mini project	-	-	-	-	-	-	-
ESE	-	10	25	15	10	40	100

23EEEE03	PROJECT PHASE I	SEMESTER III

PREREQUISITES : NIL	CATEGORY	L	T	P	C
	EEC	0	0	12	6

Course Objectives	To identify a specific problem for the current need of the problem, collecting information related to the same through detailed review of literature and to develop the methodology to solve the identified problem.

SYLLABUS

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 180 Periods Total: 180 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the research problems based on current scenario.	K2
CO2	Collect the literatures relevant to the research problem identified.	K3
CO3	Critically assess and propose solutions to environmental engineering problems.	K4
CO4	Perform analytical and experimental investigation.	K5
CO5	Demonstrate the research findings and present the solutions of the thesis work.	K6

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
23EEEE03	3	3	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	10	25	15	10	40	100
CAT2	-	10	25	15	10	40	100
Individual Assignment 1/ Case Study 1/ Seminar 1/ Mini project	-	-	-	-	-	-	-
ESE	-	10	25	15	10	40	100

23EEEE04	PROJECT PHASE II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

Course Objectives	To solve the identified problem based on the formulated methodology, and to develop skills to analyze and discuss the test results and make conclusions.

SYLLABUS

The student should continue the Phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total: 360 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the research problems based on current scenario.	K2
CO2	Collect the literatures relevant to the research problem identified.	K3
CO3	Critically assess and propose solutions to environmental engineering problems.	K4
CO4	Perform analytical and experimental investigation.	K5
CO5	Demonstrate the research findings and present the solutions of the thesis work.	K6

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
23EEEE04	3	3	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	10	25	15	10	40	100
CAT2	-	10	25	15	10	40	100
Individual Assignment 1/ Case Study 1/ Seminar 1/ Mini project	-	-	-	-	-	-	-
ESE	-	10	25	15	10	40	100

23EEPE01	SUSTAINABLE ENVIRONMENTAL MANAGEMENT					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To emphasize the need on sustainable development, cleaner production, waste audit, environmental health and safety and to impart knowledge on green process management in various industries.					
UNIT – I	**SUSTAINABLE DEVELOPMENT**					**9 Periods**
Concepts of Sustainable Development - Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability - Resource Degradation - Industrialization and Sustainable Development - Socio Economic Policies for Sustainable Development						
UNIT – II	**CLEANER PRODUCTION**					**9 Periods**
Clean Development Mechanism, - Principles and Concepts of Cleaner Production - Definition - Importance - Historical Evolution - Benefits - Promotion - Barriers - Source Reduction Techniques - Process and Equipment Optimization, Reuse, Recovery, Recycle, Raw Material Substitution – Waste Audit						
UNIT – III	**CARBON TRADING**					**9 Periods**
Green House Gases and Carbon Credit - Carbon Sequestration- Sustainable Development through Trade - Carbon Trading – Carbon footprint						
UNIT – IV	**ENVIRONMENTAL HEALTH AND SAFETY**					**9 Periods**
Ecotoxicology - Hazards by Industry and its Environmental Effects - Relationship of Occupational Hygiene / Safety and Disease - Overview, Planning, Hazard Identification and Risk Assessment - Pesticides and Environment.						
UNIT – V	**GREEN PROCESS MANAGEMENT**					**9 Periods**
Green Energy and Green Process Management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel Industries.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"Understanding Sustainable Development",*** *John Blewitt, Third edition, Taylor & Francis Ltd., 2017.*
2	***"Cleaner Production: Toward a Better Future",*** *Francisco Jose Gomes da Silva , Ronny Miguel Gouveia , Springer Publications, 2020.*
3	***"The Carbon Footprint Handbook"*** *Subramanian Senthilkannan Muthu, Taylor & Francis Ltd., 2015.*
4	***"Safety, Health, and Environment"****, NAPTA, 2nd Edition, Pearson Publications, 2019.*
5	***"Green Business Process Management",*** *Jan Recker, Stefan Seidel, Springer Publications, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Implement the sustainable development through various strategies.	K3
CO2	Execute various practices of cleaner production.	K3
CO3	Perform waste audit and evaluate carbon footprint to achieve sustainable development.	K3
CO4	Examine the toxicological and hazardous effects of Industries on Environment.	K3
CO5	Apply green process management in various industrial sectors.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	3	2	3	3	1
CO4	3	2	2	3	3	1
CO5	3	2	2	3	3	2
23EEPE01	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE02	ENVIRONMENTAL IMPLICATIONS OF ENGINEERED NANOMATERIAL				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	Creating an awareness on nanotechnology and their applications and impart knowledge on nano toxicology	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to nanotechnology – types of nanomaterials – natural and engineered nanoparticles – Properties of Nanomaterials - synthesis: Physical, chemical and Biosynthesis of Nanoparticles – characterization of nanoparticles – nanotechnology products – Environmental benefits of nanotechnology.		
UNIT – II	**APPLICATIONS OF NANOTECHNOLOGY**	**9 Periods**
Nanoparticles in energy and environment application -Fuel cell technologies –- nanotechnology for water remediation – use of nanomaterials for environmental remediation - nanomaterial based photo catalyst – kinetics of degradation –Nanolithography – Biomedical application.		
UNIT – III	**NANOTOXICOLOGY**	**9 Periods**
Nanotoxicology – toxicity of engineered nanoparticles - Health threats and effects of nanoparticles – Entry routes into the human body – Threshold-permissible limits - Portals of entry and target tissue-routes of entry of pollutants- Impact on Environmental health – Occupational exposure.		
UNIT – IV	**NANOMATERIAL–POLLUTION AND CONTROL STRATEGIES**	**9 Periods**
Nanopollution – Nanomaterials in environment - sources of pollution-transport through environment-Pollution control strategies.		
UNIT – V	**SUSTAINABLE NANOTECHNOLOGY**	**9 Periods**
Applications of Industrial ecology to nanotechnology- Fate of nanomaterials – Environmental life cycle analysis of nanomaterials – Environmental reconnaissance and surveillance – Corporate social responsibility for nanotechnology – Nanomaterials in future.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES

1	***"Introduction to Nanoscience"*** *by Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, Anil K. Rao. CRC Press, 2008.*
2	***"Handbook of Nanofabrication"*** *Edited by Gary Wiederrcht. Elsevier, 2010*
3	***"Nanotechnology: Health and Environmental risk"*** *by Jo Anne Shatkin. CRC press, 2008.*
4	***"Nanotechnology: An Introduction to Synthesis Properties and Applications of Nanomaterials"****, Thomas Varghese, K.M. Balakrishna, Atlantic publications, Reprint 2016 edition.*
5	***"Textbook of Nanoscience and Nanotechnology (Universities Press- IIM Series in Metallurgy and Materials Science)"****, B S Murty, P Shankar, Baldev Raj, Springer publications, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Implement the nanotechnology through various method.	K2
CO2	Execute various practices of nanotechnology.	K3
CO3	Implement the nanotoxicology in various field.	K3
CO4	Examine the nanotechnology in pollution control on Environment.	K3
CO5	Apply sustainable nanotechnology.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	1
CO2	3	2	2	3	3	2
CO3	3	3	2	3	3	1
CO4	3	2	2	3	3	1
CO5	3	2	2	3	3	1
23EEPE02	3	3	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	10	5	5	100
CAT2	20	40	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE03	ENVIRONMENTAL ENGINEERING STRUCTURES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To acquire knowledge on design of pipes, roofing structures, water tanks, special structures and to develop knowledge on repair and rehabilitation of structures.					
UNIT – I	**DESIGN OF PIPES**					**9 Periods**
Structural design of Concrete, Prestressed Concrete, Steel and Cast-iron pipes - piping mains – joints – Leak detection - Advances in the manufacture of pipes.						
UNIT – II	**DESIGN OF CONCRETE ROOFING SYSTEMS**					**9 Periods**
Design of concrete roofing systems – Cylindrical, Spherical and Conical shapes using membrane theory and design of various types of concrete folded plates for roofing.						
UNIT – III	**ANALYSIS AND DESIGN OF WATER TANKS**					**9 Periods**
IS Codes for the design of water retaining structures - Design of circular, rectangular, spherical and Intze type of tanks using concrete.						
UNIT – IV	**DESIGN OF SPECIAL PURPOSE STRUCTURES**					**9 Periods**
Design of Underground reservoirs, swimming pools, Intake towers, settling tanks, clari - flocculators, aeration tanks.						
UNIT – V	**REPAIR AND REHABILITATION OF STRUCTURES**					**9 Periods**
Diagnosing the cause and damage, identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures - Durability of Structures used in water and sewerage works.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"The Fundamentals of Piping Design"**, Peter Smith, Elsevier Science, 2013.*
2	***"Advanced Reinforced Concrete Design",** N. Krishna Raju, CBS Publishers & Distributors, Third edition, 2016.*
3	***"Reinforced Concrete Design",** S Unnikrishna Pillai, Devdas Menon, Tata McGraw Hill Foundation Private Limited,2017*
4	***"Maintenance, Repair & Rehabilitation & Minor Works of Buildings",** P.C. Varghese, PHI Learning Private Limited, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design various piping systems based on environmental conditions.	K3
CO2	Analyze and design concrete roofing systems.	K3
CO3	Analyze and design various types of water tanks	K3
CO4	Execute the design of various special structures such as underground reservoirs, swimming pools etc.,	K3
CO5	Assess the condition of structures and suggest rehabilitation measures.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	1
CO3	3	2	2	2	2	1
CO4	3	3	2	2	2	2
CO5	2	3	2	2	3	2
23EEPE03	3	2	2	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	15	25	25	15	10	100
CAT2	10	15	25	25	15	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	-	50	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	-	50	50	-	-	100
ESE	10	15	25	25	15	10	100

23EEPE04	GROUND WATER CONTAMINATION AND TRANSPORT MODELING					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objectives	To study the basics of contaminant transport phenomenon, to identify the sources and causes of ground water pollution for predicting the suitable numerical modeling of groundwater	
UNIT – I	**INTRODUCTION TO GROUND WATER**	**9 Periods**
Ground water and the hydrologic cycles; Ground water and geologic processes. Physical properties and principles - Darcy's Law - Hydraulic Head and Fluid Potential - Piezometers and Nests. Hydraulic conductivity and permeability - Homogeneity and Anisotropy - Porosity and voids Ratio - Unsaturated flow and the water table - Steady state flow and Transient flow - Compressibility and effective stress.		
UNIT – II	**BASICS OF CONTAMINANT TRANSPORT**	**9 Periods**
Transport phenomenon – advection - diffusion – dispersion — adsorption - conservative and non - conservative pollutants- Extrinsic and Intrinsic properties- laws of conservation- Reynolds Transport Theorem.		
UNIT – III	**GROUNDWATER CONTAMINATION**	**9 Periods**
Groundwater contamination, sources and causes of groundwater pollution. Pollution Dynamics, Hydrodynamics dispersions, Biodegradations, Radioactivity decay, Reactive processes, Multiphase contamination, NAPLs, VOCs, Site specific groundwater quality problems in Indian context.		
UNIT – IV	**TRANSPORT MODELING**	**9 Periods**
Numerical models, Finite difference methods, Numerical modelling of steady and transient flows in saturated and unsaturated domains, Contamination transport modelling, Application of FEM and BIEM in groundwater modelling, regional aquifer simulation.		
UNIT – V	**GROUNDWATER MANAGEMENT**	**9 Periods**
Contaminated groundwater systems and their rehabilitation, Development and optimization-based management of aquifer systems, stochastic models, Random field concepts in groundwater models; Application emerging techniques to groundwater management.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	***"Ground water Hydraulics and Pollutant transport"****, Randall J. Charbeneau, Prentice Hall, Upper Saddle River, 2009.*
2	***"Ground water Hydrology",*** *Todd David Keith, Second edition, John Wiley and Sons, New York, 2010.*
3	***"Ground water"****, Allen Freeze, R. and John A. Cherry,* ***"Ground Water"****, Prentice Hall, Inc., 2009.*
4	***"Modelling Ground Water Flow and contaminant Transport"****, Bear, Jacob, cheng, Alexander H.D. 2010.*
5	***"Ground Water Contamination: Transport and Remediation"****, Philip B, Bedient, Hanadis, Rifari,chareless J,NEWELL 1999.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the hydrogeological parameters which influence the availability of ground water.	K1
CO2	Know the basics of contaminant transport phenomenon and pollutant nature.	K2
CO3	Examine the causes for ground water pollution at site and its pollution dynamics.	K3
CO4	Develop the Contamination transport modelling for solving real problems.	K3
CO5	Analyze the groundwater management techniques for contaminated aquifers.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2	2	1
CO2	3	2	1	2	2	1
CO3	3	2	2	2	2	1
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2
23EEPE04	3	3	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	35	35	-	-	-	100
CAT2	30	30	30	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	30	40	30	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	20	25	30	20	5	-	100

23EEPE05	ENVIRONMENTAL IMPACT ASSESSMENT

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Understanding, assessing the various environmental impacts and social impacts of EIA and identifying the risk identification sources and providing management plan

UNIT – I	INTRODUCTION	9 Periods

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – EIA process- screening –scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA-EIA Consultant Accreditation.

UNIT – II	IMPACT IDENTIFICATION AND PREDICTION	9 Periods

Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment.

UNIT – III	SOCIAL IMPACT ASSESSMENT AND EIA DOCUMENTATION	9 Periods

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials.

UNIT – IV	ENVIRONMENTAL MANAGEMENT PLAN	9 Periods

EIA Report preparation. Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.

UNIT – V	ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT	9 Periods

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modeling of contaminant-Risk Characterization Risk communication – Emergency Preparedness Plans –Design of risk management programs.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Environmental Impact Assessment- Theory and Practice,"**, Wathern, P, Taylor and Francis Group, U.K. 2015*
2	***"Methodologies in Hazard Identification and Risk Assessment"**, Raghavan K. V. and Khan A A by CLRI, 1990*
3	***"Environmental Impact Assessment: Practical Solutions to Recurrent Problems",** Lawrence, D.P., John Wiley & Sons, Canada (2003)*
4	***"Environmental Risk and Hazards",** Cutter, S.L Hall of India Pvt. Ltd., New Delhi, Bimal Kanti Paul 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret the importance of environment assessment studies in project development.	K2
CO2	Apply impact identification and prediction models.	K3
CO3	Prioritize the social impacts in EIA documentation.	K3
CO4	Articulate the environmental management plan including the preparation and mitigation aspects.	K3
CO5	Evaluate the risk assessment based on dose response analysis	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	3	1
CO2	3	3	2	2	2	1
CO3	2	2	3	2	3	2
CO4	3	2	2	3	3	2
CO5	3	2	2	3	3	3
23EEPE05	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	35	10	5	-	100
CAT2	25	25	35	10	5	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	10	10	35	45	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	10	10	35	45	-	-	100
ESE	25	25	40	10	-	-	100

23EEPE06	ENVIRONMENTAL ECONOMICS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	Balancing between economic development, environmental quality and also to determine the theoretical or empirical effects of environmental policies on the economy.					
UNIT – I	**ECONOMY AND THE NATURAL ENVIRONMENT**					**9 Periods**
The human economy – natural environment interaction. Biophysical Foundations of production and consumption of human economy Sources and Sink functions of the ecosystem. Material Balance approach: the concept and conditions of sustainability of the human economy. Classification and characterization of resources and pollution as a public good or bad. Role of Externalities as the fundamental determinants. Property Rights, Market, Spatial-temporal dimensions of externality.						
UNIT – II	**THEORY OF ENVIRONMENTAL REGULATION AND POLICY**					**9 Periods**
The socially optimal level of pollution and Pareto optimal allocation of resources. attainment of optimal pollution: **Assignment of Property Rights:** Coase Theorem and its limitations, Government interventions - Command and Control: standard setting, Market based instruments: Pigouvian taxes - emission charges, ambient charges, product charges, subsidies, noncompliance fees, Tradable pollution permits. Uncertainty and choice of regulatory instrument.						
UNIT – III	**VALUATION OF ENVIRONMENTAL GOODS AND SERVICES**					**9 Periods**
Environmental valuation and conceptual basis of its methods: Compensating Variations and Surplus, Equivalent Variations and Surplus, Willingness to pay or accept for improvement or loss of environmental goods and services. Empirical approaches in environmental valuation: Indirect Methods of environmental valuation: econometric or statistical methods. Preference Methods: (a) Hedonic Pricing, (b) Household Production Function approach - defensive cost, health cost and travel cost methods. The direct method of environmental valuation: Stated preference: Contingent valuation method.						
UNIT – IV	**SUSTAINABLE ECONOMIC DEVELOPMENT**					**9 Periods**
Capital theoretic basis of the notion of sustainable development: Sustainable Development as non-declining intertemporal utility or that of the value of the wealth. Concepts of Genuine investment or savings and Green National Income. Natural capital stock and sustainable resource accounting. Strong and weak Sustainability, Environmental Adjustment of National Income.						
UNIT – V	**ECONOMIC DEVELOPMENT AND ENVIRONMENT**					**9 Periods**
The relation between Development and Environmental Quality: Environmental Kuznets Curve Development vs conservation of environmental resources: Ecosystem flips and irreversibility: Krutilla-Fisher equation. Environmental Cost-Benefit Analysis under strong and weak conditions of sustainability: Choice of time discount rate for evaluation. Sustainability premium.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*"**Environmental Economics: Theory and Applications"**, Katar Singh, Anil Shishodia, SAGE Publications, First Edition, 2007.*
2	***"Economics of Environment"**, SunhashiniMuthukrishnan, PHI Learning Pvt. Ltd. Publications, Second Edition, 2015.*
3	***"Intermediate Environmental Economics"**, Charles Kolstad, Oxford University Press, 2nd edition, 2010.*
4	***"Economics of the Environment: Selected Readings"**, Robert N. Stavins, W.W.Norton, 5th edition, 2005.*
5	***"Natural Resource and Environmental Economics"**, Roger Perman, Yue Ma, James McGilvray and Michael Common", Pearson Education/Addison Welsey, 3rd edition, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the economy and the natural environment	K2
CO2	Emphasize the Environmental regulation and policy	K3
CO3	Valuate the environmental goods and services	K3
CO4	Summarize the sustainable economic development	K3
CO5	Predict the economic development and environment	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	2	3	2	-
CO2	2	2	3	2	2	-
CO3	2	3	2	2	3	-
CO4	2	3	2	3	3	-
CO5	2	3	3	2	2	-
23EEPE06	2	3	3	3	3	-
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	25	10	10	-	100
CAT2	20	20	25	15	20	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	20	30	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	25	25	50	-	-	100
ESE	20	25	20	25	10		100

23EEPE07	COMPUTING TECHNIQUES IN ENVIRONMENTAL ENGINEERING					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To understand different methods, tools of computing techniques for solving environmental problems for interpretation of the Environmental Impacts using modern advanced computing tools used in environmental studies.					
UNIT – I	**COMPUTING PRINCIPLES**					**9 Periods**
Introduction to Computing techniques – Algorithms and Flowcharts, Numerical methods -Solution to ordinary and partial differential equation using Finite difference and Finite element method, Numerical integration and differentiation, Design of digital models for Environmental applications.						
UNIT – II	**ARTIFICIAL INTELLIGENCE**					**9 Periods**
Knowledge based Expert system concepts - Principle of Artificial Neural Network (ANN) –Neural Network Structure – Neural Network Operations – ANN Algorithm - Application of ANN Model to Environmental field – Genetic Algorithms.						
UNIT – III	**FUZZY LOGIC**					**9 Periods**
Fuzzy sets, fuzzy numbers, fuzzy relations, fuzzy measures, fuzzy logic and the theory of uncertainty and information; applications of the theory to inference and control, clustering, and image processing - Network analysis models.						
UNIT – IV	**DATA MANAGEMENT**					**9 Periods**
Data base structure - Data acquisition - Data warehouse - Data retrieval-Data format Attribute -RDBMS - Data analysis - Network data sharing - Statistical Analysis (SYSTAT) - Regression -factor analysis - histogram - scatter diagram - Goodness of fit.						
UNIT – V	**ENVIRONMENTAL MODELING USING MATLAB**					**9 Periods**
Introduction to MATLAB Software – Environmental modeling principles and MATLAB Applications – Pollutants transport, decay and degradation modeling using MATLAB. Case studies.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"Soft Computing and its Applications",*** *Aliev R. A, and Aliev Rashad, World Scientific Publications Co. Pte. Ltd. Singapore, 2014.*
2	***"Numerical Methods for Engineers",*** *Chepra S. C. and Canele R. P., McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, NewYork, NY 10020. 6th Edition 2014.*
3	***"Data-Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering",*** *Springer; 2014 edition.*
4	***"Numerical methods using MATLAB",*** *Mathews J. H. and Fink K.D, Pearson Education2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Examine the principle of soft computing for the analysis and design of engineering systems.	K3
CO2	Articulate the environmental impacts using ANN	K3
CO3	Solve the environmental impacts using fuzzy logic	K3
CO4	Discover the data for effective management plan.	K3
CO5	Use advanced computing tools in environmental studies	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	2	1
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	3	3	3	3	2
CO5	2	3	2	3	3	2
23EEPE07	3	3	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	20	40	10	-	-	100
CAT2	30	20	40	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	20	40	20	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	20	40	20	-	-	100
ESE	30	20	40	10	-	-	100

23EEPE08	ENVIRONMENTAL RISK ASSESSMENT				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	Understanding the important elements and sources of environmental hazards to demonstrate the tools and methods of risk assessment and management.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Environmental Risk and definitions -Sources of Environmental hazards – Environmental risk assessment framework – Regulatory perspectives and requirements – Risk Analysis and Management - Path to risk analysis; Perception of risk, risk assessment in different disciplines.		
UNIT – II	**ELEMENTS OF ENVIRONMENTAL RISK ASSESSMENT**	**9 Periods**
Hazard identification – Fate and behaviour of toxics and persistent substances in the environment – Properties, processes and parameters that control fate and transport of contaminants – Receptor exposure to Environmental Contaminants – Dose Response Evaluation – Exposure Assessment – Exposure Factors, Slope Factors, Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis.		
UNIT – III	**TOOLS AND METHODS FOR RISK ASSESSMENT**	**9 Periods**
HAZOP and FEMA methods – Cause failure analysis – Event tree and fault tree modeling and analysis – Multimedia and multipath way exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products – Estimation of carcinogenic and non-carcinogenic risks to human health – Methods in Ecological risk assessment – Probabilistic risk assessments – radiation risk assessment – Data sources and evaluation.		
UNIT – IV	**ENVIRONMENTAL RISK MANAGEMENT**	**9 Periods**
Risk communication and Risk Perception – comparative risks – Risk based decision making – Risk based environmental standard setting – Risk Cost Benefit optimization and tradeoffs – Emergency Preparedness Plans – Emergency planning for chemical agent release – Design of risk management programs – risk based remediation; Risk communication, adaptive management, precaution and stake holder involvement.		
UNIT – V	**APPLICATIONS**	**9 Periods**
Case studies on risk assessment and management for hazardous chemical storage – Chemical industries – Tanneries – Textile industries – Mineral processing and Petrochemical plants – Hazardous waste disposal facilities – nuclear power plants – contaminated site remediation – Case histories on Bhopal.		

Contact Periods:

Lecture:45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Environmental Health and Hazard Risk Assessment,"****, Theodore L and Dupont R R, CRC Press (2012).*
2	***"Environmental Impact Assessment Methodologies",*** *Anjaneyulu Yerramillivalli, Manickam (2020),3rd Edition, BS Publication, 2020*
3	***"Environmental impact assessment",*** *m.anjireddy, bs publication , 2016*
4	***"Environmental risk assessment: a toxicological approach"****, tedsimon, 2014.*
5	***"Environmental Risk Assessment and Management from a landscape perspective"****, Wayne landis, Lawrence A. Kapustka, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret different types of risk and environmental risk assessment.	K2
CO2	Use elements involved in environmental risk assessment and hazard prediction.	K2
CO3	Identify the analyzing tools and methods for risk assessment.	K3
CO4	Evaluate risk communication and risk perception.	K3
CO5	Appraise the risk assessment for different industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	2	1
CO2	2	2	2	3	3	1
CO3	2	3	3	2	3	2
CO4	3	2	3	3	2	2
CO5	3	2	3	2	3	3
23EEPE08	3	3	3	3	3	3
1-Slight, 2- Moderate, 3- Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	25	10	10	-	100
CAT2	25	30	25	10	10	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	10	20	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	10	20	10	-	100
ESE	30	35	25	10			100

23EEPE09	ENVIRONMENTAL MANAGEMENT STANDARDS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To impart an understanding of systems approach to Environmental Management Standards, gain knowledge about audit process, qualification criteria, labels, self-declaration and Environmental Performance Evaluation Guidelines, and enhance skills for Life Cycle Impact Assessment and Life Cycle Interpretation.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Environmental Management system- definition and goal, Need for EMS implementation, International standard organaisation – Functions of ISO, - ISO 14000 series-Introduction, objective and Goal. Scope of the standards of ISO 14000 series						
UNIT – II	**ENVIRONMENTAL MANAGEMENT SYSTEMS**					**9 Periods**
ISO 14001- Environmental Management Systems: Specification with Guidance for Use, ISO 14004 :EMS General Guidelines on Principles, Systems and Supporting Techniques						
UNIT – III	**ENVIRONMENTAL AUDITING**					**9 Periods**
General Principles, Audit Procedures: Auditing of Environmental Management Systems, Qualification Criteria for Environmental auditors, Environmental Assessment of Sites and Organisations- ISO 14015						
UNIT – IV	**ENVIRONMENTAL LABELS AND DECLARATIONS**					**9 Periods**
Environmental Labels and Declarations: General principles, Types of labeling. ISO 14021 (2001): Environmental Labels and Declarations: Self-declared Environmental Claims (Type II Environmental Labelling), ISO 14024 (2001): Type I Environmental Labels: Principles and Procedures Environmental Management: Environmental Performance Evaluation Guidelines- ISO 14031- case studies.						
UNIT – V	**LIFE CYCLE ASSESSMENT**					**9 Periods**
Introduction, Life Cycle Assessment: Principles and Framework- ISO 14040, Goal and Scope Definition and Inventory Analysis- ISO 14041, Life Cycle Impact Assessment - ISO 14042, Life Cycle Interpretation- ISO 14043, Data Documentation Format- ISO 14048.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"ISO 14000 Environmental Management Standards: Engineering and Financial Aspects",*** *Dr.Alan Morris, Wiley Publications, 2004.*
2	***"Concepts of Environmental Management for Sustainable Development",*** *M C.Dash, Wiley Publications, 2019.*
3	***"Introduction to Environmental Management"****, M.M.Sulphey, M.M.Safeer, PHI Learning Publications, 2017.*
4	***"Environmental Management",*** *R.K.Mishra, AITES Publications, 1st Edition, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Value the elements and scope of the standards	K2
CO2	Discuss the guidelines on principles and supporting techniques	K2
CO3	Develop the auditing process and procedures	K3
CO4	Discuss Environmental labels, types and declaration	K3
CO5	Implement Life Cycle Assessment and Impact Assessment	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	2	1
CO2	3	2	2	2	2	1
CO3	2	2	3	2	3	1
CO4	2	2	3	2	3	1
CO5	2	2	2	2	3	1
23EEPE09	3	2	3	2	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	25	20	25	10	-	100
CAT2	20	20	25	15	20	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	10	40	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	15	35	50	-	-	100
ESE	20	15	25	25	15	-	100

23EEPE10	AIR QUALITY MODELING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	Understanding the concept of different types of air quality models, emphasizing the importance of meteorological condition in air quality model ,gaining knowledge on indoor air quality models and advanced software in air quality modeling

UNIT – I	MODELING CONCEPT	9 Periods

Overview of different types of models-deterministic and stochastic approach- Steps in model development-numerical and simulations models- calibration and validation of models-Limitations- Transport phenomena- Mass balance analysis-Model development and decision making.

UNIT – II	AIR POLLUTION MODELING	9 Periods

Chemistry of air Pollutants - Atmospheric reactions, sinks for air pollution –Transport of air Pollutants - Meteorological settling for dispersal of air pollutants – Vertical structure of temperature and stability, atmospheric motions, Wind and shear, self-cleaning of atmosphere; transport and diffusion of stack emissions – atmospheric characteristics significant to transport and diffusion of stack emission – stack plume characteristics.

UNIT – III	AIR QUALITY MODELS	9 Periods

Types modeling technique, modeling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Fixed box models- diffusion models – Gaussian plume derivation- modifications of Gaussian plume equation- long term average-multiple cell model receptor oriented and source-oriented air pollution models- model performance, accuracy and utilization-air Quality Index -air quality mapping.

UNIT – IV	INDOOR AIR QUALITY MODELS	9 Periods

Indoor Air Pollutants - Volatile Organic Compounds, Inorganic Gaseous Pollutants Respirable Particulates, Bio aerosols, Radon and its decay products-Infectious disease transmission- A/C units in indoor- Odors and sick building syndrome-Indoor Air quality Models.

UNIT – V	SOFTWARE PACKAGE APPLICATIONS	9 Periods

Commercial air quality models -ADMS, Air viro and USEPA models

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	***"Air Quality: Monitoring and Modeling",*** *Sunil Kumar, Rakesh Kumar, bod – Books on Demand Publisher, 2012.*
2	***"Air Pollution Modeling and its Application XXVI",*** *Clemens Mensink, Wanmin Gong, Amir Hakami, Springer Nature, 2019.*
3	***"Air Quality: Monitoring, Measuring, and Modeling Environmental Hazards",*** *Marco Ragazzi, CRC Press, 2016.*
4	***"Air Quality: Modeling and Assessment",*** *Frieda Bush, Callisto Reference, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify different mathematical models and their limitations.	K2
CO2	Utilize air pollution modeling parameters in appropriate places	K3
CO3	Develop conceptual schematics required for air quality modeling	K3
CO4	Discover indoor air quality models with different indoor air pollution sources.	K3
CO5	Appraise the advanced software in air quality modeling	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2	2	1
CO2	2	3	2	2	2	1
CO3	2	3	2	2	2	1
CO4	2	3	2	2	2	1
CO5	2	3	1	2	2	3
23EEPE10	3	3	2	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	40	10	-	-	100
CAT2	25	25	40	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	10	10	35	45	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	10	10	35	45	-	-	100
ESE	25	25	40	10	-	-	100

23EEPE11	ENVIRONMENTAL SYSTEM ANALYSIS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	Develop conceptual schematics for ecological modeling, models for dissolved oxygen and pathogens, Activated sludge process schemes, linear optimization models, parameter estimation and experimental design.					
UNIT – I	**ECOLOGICAL SYSTEM**					**9 Periods**
Basic concepts in ecology and ecological modeling, population dynamics: birth and death Processes. Single species growth, prey-predator models: Lotka - Volterra, Rosenzweig-macarther, Kolmogorov models. Multi-species modelling - structural analysis and stability of complex Ecosystems.						
UNIT – II	**REACTOR MODELING**					**9 Periods**
CSTR, plug-flow, dispersion. A case study of a tubular reactor with axial dispersion, parameter calibration: search algorithms for nonlinear dynamical models, variance of estimated parameters. Application to Monod and Haldane kinetics.						
UNIT – III	**WATER QUALITY MODELING**					**9 Periods**
Rivers and streams water quality modelling -dispersion and mixing- water quality modelling process- model sensitivity-assessing model performance; models for dissolved oxygen and pathogens- pollutant and nutrient dynamics -dissolved oxygen dynamics -groundwater quality modeling.						
UNIT – IV	**MICROBIAL DYNAMICS AND ENERGETICS**					**9 Periods**
Requirements for carbon and nutrient removal. Activated sludge: process schemes: completely Mixed, plug-flow, SBR, nutrient removal. Anaerobic digestion: process dynamics, operational Control of wastewater treatment processes.						
UNIT – V	**COMPUTER BASED SOLUTIONS**					**9 Periods**
Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models-simulation, parameter estimation and experimental design.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	***"Environmental Systems Philosophy, Analysis and Control"*** *book by Robert John Bennett and Richard J. Chorley, Princeton University press publication,2015*
2	***"Environmental System Analysis"*** *book by Stefano Marsili-libelli, CRC press* publication, 2016
3	***"Environmental System Modelling"*** *book by Dr.R.K. Prasad, Standard publishers & Distributors, 2016*
4	***"Introduction to System Analysis Basic Concepts and App"*** *book by Dieter M. Imboden, Stefan D Fenninger, Springer Berlin Heidelberg publications, 14th December 2012*
5	***"Environmental Pollution Analysis"*** *book by SM. Khopkhar ,2nd Edition, New age international publication, 2020*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe ecological modeling, single and multi-species modeling on a brief	K2
CO2	Explain modeling of CSTT and the kinetics of reaction taking place in it	K3
CO3	Analyze and model the river system and also ground water system	K3
CO4	Analyze the wastewater treatment system	K3
CO5	Demonstrate computational techniques for modeling	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	2	-
CO2	2	2	3	3	2	-
CO3	3	3	3	3	3	-
CO4	2	2	3	3	3	-
CO5	3	3	3	2	2	-
23EEPE11	3	3	3	3	3	-
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	10	30	45	-	-	100
CAT2	15	10	30	45	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	20	30	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	20	30	50	-	-	100
ESE	15	10	30	45			100

23EEPE12	REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	• To comprehend the fundamentals of remote sensing and the data acquisition process. • To explore the principles and applications of diverse remote sensing techniques and systems. • To provide an insight of image processing techniques, GIS concepts, and geodatabase structure. • To employ knowledge of remote sensing and geographic information systems (GIS) in resource management and pollution monitoring. • To employ geospatial knowledge to environmental applications using GIS and image processing software.

UNIT – I	**FUNDAMENTALS OF REMOTE SENSING**	**9 Periods**
Introduction to remote sensing – Principles of Electro – Magnetic Radiation – Energy/Matter interaction with Atmosphere and land surface – spectral reflectance of earth materials and vegetation – Data products.		
UNIT – II	**AERIAL PHOTOGRAPHY AND SATELLITE REMOTE SENSING**	**9 Periods**
Aerial Photography – Photogrammetry and Visual Image Interpretation. Various satellites in orbit and their sensors – Resolutions – Multispectral Remote Sensing system (MSS)and design – VISIBLE - NIR remote sensing - Thermal IR Radiation properties, systems and application – Microwave and LIDAR remote sensing – Principles and applications.		
UNIT – III	**DATA ANALYSIS AND GIS**	**9 Periods**
Data Analysis – Visual interpretation and digital image processing – Classification. Introduction to GIS, concepts and data base structure, various GIS software.		
UNIT – IV	**REMOTE SENSING AND GIS APPLICATIONS**	**9 Periods**
Applications of Remote sensing and GIS – Management and Monitoring of Land, air, water and pollution studies – conservation of resources – coastal zone management –Limitations.		
UNIT – V	**CASE STUDIES AND SOFTWARE APPLICATIONS**	**9 Periods**
GIS and image Processing software. ArcGIS Spatial analysis- Land suitability Analysis – Watershed analysis – Hazard zoning. Envi - Digital image processing – Land use and Landcover classification- Water quality assessment – Case studies.		

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Text Book of Remote Sensing and Geographical Information Systems",*** *Anji Reddy, Fourth edition, BS Publications, 2022.*
2	***"Remote sensing applications",*** *M.G. Srinivas Narosa publishing house, 2001.*
3	***"Remote Sensing and Geographical Information System",*** *A M. Chandra and S. K. Ghosh, second edition, Narosa Publishing House, 2016*
4	***"Application of GIS and Remote Sensing in Environmental Management",*** *Abbasi.S.A., Discovery Publication, 2010*
5	***"Principles of Geographical Information System",*** *Burroughs P.A, Third edition, Oxford University Press, 2016.*
6	***"Remote Sensing and Image Interpretation",*** *Thomas Lillesand, Seventh Edition, John Wiley Sons, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Comprehend remote sensing principles and investigate the reflectance properties of earth features.	K2
CO2	Describe various remote sensing systems and their applications in earth observation.	K2
CO3	Apply image processing techniques on satellite images and have a full knowledge of GIS concepts and database structure.	K3
CO4	Employ remote sensing and geographic information systems (GIS) to monitor and manage the environment.	K3
CO5	Employ GIS and image processing tools for environmental applications.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	2	1
CO2	3	2	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2
23EEPE12	3	3	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	20	30	25	15	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	35	35	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE13	SOIL POLLUTION CONTROL					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To identify various soil pollution sources and its effect on the ecosystem for analyzing the interaction between soil and pollutants and their mechanisms to select appropriate remediation techniques.					
UNIT – I	**SOIL POLLUTION AND ITS SOURCES**					**9 Periods**
Introduction-Sources of Pollution-Point source pollution and diffuse soil pollution- Natural, Geogenic Sources-Industrial, Agricultural, livestock activities-mining and urban expansion and infrastructural activities-failure of geostructures on contaminated sites- Case studies.						
UNIT – II	**IMPACT OF SOIL POLLUTION ON ECOSYSTEM**					**9 Periods**
Geological Structure-soil structure-Ecosystem-food chain contamination-use of fertilizers and pesticides, soil pollution from agriculture-Acidification-crop loss-pathways of exposure of human beings-Ecosystem stability.						
UNIT – III	**SOIL POLLUTANT INTERACTION**					**9 Periods**
Current practices of disposal of waste-factors governing soil pollution interaction- Contaminant Transport Mechanism-Processes-Soil- Chemical kinetics -Governing equations-coupling of contaminant-soil interactions with transport-solute transport modelling software.						
UNIT – IV	**ASSESSMENT OF CONTAMINATED SITES**					**9 Periods**
Site Investigation-Risk Assessment- surface and ground water contamination, land contamination, health risks-waste containment in landfills, leachate-monitoring facilities- IoT Technologies-Case studies.						
UNIT – V	**REMEDIATION TECHNOLOGIES**					**9 Periods**
Factors influencing bioremediation- Contemporary approaches to remediation- -Physical, Chemical and Biological methods- Limitations- Phyto stabilization- pump and treat method, permeable reactive barriers. Stabilization methods –Solidification- Thermal method-reclaimed sites- Current Practices and Applications.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"Soil Pollution, Monitoring and Remediation",*** *Ibrahim A. Mirsal, Springer-Verlag Berlin Heidelberg, 2008.*
2	***"Fundamentals of Environmental Site Assessment and Remediation",*** *YueRong, CRC Press, 2018.*
3	***"Contaminated Land: Investigation, Assessment and Remediation – Design and Practice Guides",*** *Jo Strange and Nick Langdon, ICE, 2008.*
4	***"Geo-Environmental Engineering",*** *HariD.Sharma and Krishna R.Reddy,John Wiley and Sons, INC, USA, 2004.*
5	***"Applied Ground Water modelling: simulation of flow and advective transport"****, Anderson, Mary P., William W Woessner and Randall J. Hunt, Academic Press, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the sources of soil pollution	K3
CO2	Demonstrate the impacts of pollution on the ecosystem	K3
CO3	Explain the flow of contaminants and mass transport processes	K3
CO4	Assess the contaminated sites using conventional and modern technologies	K3
CO5	Select and apply suitable techniques for the remediation of contaminated sites.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	3
CO2	3	2	2	3	3	2
CO3	3	2	2	3	3	2
CO4	3	2	2	3	3	2
CO5	3	2	2	3	3	2
23EEPE13	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	25	15	5	5	100
CAT2	20	30	25	15	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	20	30	25	15	5	5	100

23EEPE14	HAZARDOUS WASTE MANAGEMENT					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To understand the characteristics of different types of hazardous wastes and their sources, waste minimization and resource recovery to categorize the different hazardous waste and hazardous waste management.					
UNIT – I	**INTRODUCTION TO HAZARDOUS WASTES**					**9 Periods**
Hazardous waste definition – Sources and classification –Hazardous waste characteristics - Sampling and analysis of hazardous wastes – Collection – handling - storage and transport - TSDF concept - Hazardous waste management rules and regulations.						
UNIT – II	**WASTE MINIMIZATION AND RESOURCE RECOVERY**					**9 Periods**
Waste reduction process - benefits of hazardous waste reduction - Properties in hazardous waste management - Selection of the waste minimization process - case studies on by product recovery from incineration. Transportation of hazardous wastes – Regulation - containers for hazardous materials - bulk and non-bulk transport - hazardous substances emergency response.						
UNIT – III	**HAZARDOUS WASTE MANAGEMENT: NUCLEAR AND BIOMEDICAL WASTE**					**9 Periods**
Nuclear waste - Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors – Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects - Biomedical waste - Introduction to biomedical wastes - sources – classification - collection – segregation - treatment and disposal - Biomedical waste management rules.						
UNIT – IV	**HAZARDOUS WASTE MANAGEMENT: E-WASTE AND PLASTIC WASTE**					**9 Periods**
E-waste – Introduction - characteristics - generation – collection – transport - recycling and disposal methods - Effects of e-wastes on the society and environment - E-waste waste management rules - Plastic waste – Sources – Production - Global and Indian Context - Plastic Waste Management Practices –recycling - energy production - other application.						
UNIT – V	**HAZARDOUS WASTE DISPOSAL**					**9 Periods**
Land-fill disposal - Landfill at disposal sites, developing a new facility – landfill operation - Site remediation - Site assessment and inspection - the hazardous system and the national priority list - remedial action - monitoring of disposal sites.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***CPHEEO (2016), "Manual of Municipal Solid Waste Management"****, Ministry of Urban Development, India.*
2	***"Integrated Solid Waste Management, Engineering Principles and Management Issues",*** *Tchobanoglous G, Theisen H, Vigil S.A., 2nd Edition.*
3	***"BASIC HAZARDOUSWASTE MANAGEMENT"*** *book by William Blackman,3rd Edition, 2016.*
4	***"SOLID AND HAZARDOUS WASTE MANAGEMENT"*** *book by M.N. Rao,2nd Edition, BS Publications / BSP Books; January 1 2020*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify the types of hazardous waste and their characteristics.	K2
CO2	Discover the techniques in the field to minimize waste and resource recovery.	K3
CO3	Categorize the methods and analysis of nuclear and biomedical waste management.	K3
CO4	Categorize the methods and analysis of e-waste and plastic waste management.	K3
CO5	Articulate the concepts of hazardous waste disposal in the landfill.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	1
CO4	3	3	2	3	3	1
CO5	2	2	1	3	3	2
23EEPE14	3	3	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEPE15	ADVANCED WASTEWATER TREATMENT AND REUSE					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	Advanced wastewater treatment, air stripping, nitrogen removal, Membrane separation processes, nutrient process, membrane structure and rejection mechanism, Estimation of sludge produced from chemical precipitation of phosphorous with lime in PST, and knowledge in reclamation and reuse of Wastewater, public health and environmental issues in water reuse.					
UNIT – I	**GENERAL AND STRIPPING**		**9 Periods**			
Need for advanced wastewater treatment – technologies used for advanced treatment – conventional reactor modifications in advanced treatment-oxidation processes – regulations in removal of NBOD and other nutrients- Selection of unit operation in advanced treatment Gas stripping – Analysis of gas stripping – Design of stripping towers – applications. – Air stripping of ammonia – Breakpoint chlorination – Ion exchange						
UNIT – II	**NITROGEN REMOVAL AND OXIDATION PROCESSES**		**9 Periods**			
Nutrient removal – Nitrogen removal – forms and sources of nitrogen – Biological nitrogen removal – Nitrification kinetics – Denitrification kinetics – Design parameters – Nitrogen removal by – physical and chemical processes Oxidation processes-advanced oxidation process in removal of nitrogen and phosphorus derivatives-use of peroxy, Cl- and oxy radicals in reducing COD.						
UNIT – III	**MEMBRANE SEPARTION PROCESSES AND ELECTRO DIALYSIS**		**9 Periods**			
Membrane separation processes – process classification – membrane materials-Symmetric and asymmetric membranes – membrane configuration – membrane fouling- Molecular weight cutoff – Reverse osmosis – theory – membrane structure and rejection mechanism – osmotic pressure – Transport models and flux equations – ultra filtration – Electrodialysis – theory – power requirement.						
UNIT – IV	**PHOSPHOROUS REMOVAL**		**9 Periods**			
Phosphorous removal – By biological methods – Phosphorous removal by chemical addition – chemistry of precipitation with Aluminium, calcium and Iron – Comparison of processes – Estimation of sludge produced from chemical precipitation of phosphorous with lime in PST.						
UNIT – V	**WASTEWATER RECLAIMATION AND REUSE**		**9 Periods**			
Merits and demerits of advanced treatment-applications of treated wastewater- Wastewater reclamation and reuse – The role of water recycling in the hydrologic cycle – wastewater reuse applications – public health and environmental issues in water reuse – Level of treatment – Risk Assessment – Ground water recharge with reclaimed water.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"Waste Water Engineering – Treatment and reuse",*** *Metcalf and Eddy, Fourth Edition, McGraw Hill Education, 2017.*
2	***"Waste Water Treatment and disposal",*** *Arceivala S. J., Marcel dekker publishers,1981.*
3	***"Environmental Engineering",*** *Howard S. Peavy, Donald R. Rowe and George Techobanoglous, McGraw Hill Education, 2017.*
4	***"Wastewater Treatment Plant – Planning, Design and operation",*** *QASIM S. R, Holt Rinchart and Winston, New York, 2002.*
5	***"Biological Process Design for Wastewater Treatment",*** *Larry D. Benefield and Clifford W. Randall, Prentice - Hall Series in Environmental sciences, 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Examine suitable advanced wastewater treatment for critical pollutant removal.	K3
CO2	Demonstrate kinetics involved in nitrogen removal process.	K2
CO3	Label suitable mechanism in membrane process.	K3
CO4	Enumerate methods and process for phosphorus removal.	K2
CO5	Investigate different wastewater reclamation and reuse technique.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	3	1
CO2	2	2	3	2	3	1
CO3	3	3	2	3	2	1
CO4	2	3	2	3	3	1
CO5	2	3	2	3	2	1
23EEPE15	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	30	15	15	-	100
CAT2	20	25	35	10	10	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	20	50	20	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	25	40	25	10	-	100
ESE	25	20	30	10	15	-	100

23EEPE16	ENVIRONMENTAL BIOTECHNOLOGY				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To emphasize the need on wastewater reclamation and reuse by imparting knowledge on nitrogen and phosphorus removal and on membrane process and Electro Dialysis.

UNIT – I	**GENERAL AND STRIPPING**	**9 Periods**

Need for advanced wastewater treatment – technologies used for advanced treatment – conventional reactor modifications in advanced treatment-oxidation processes – regulations in removal of NBOD and other nutrients- Selection of unit operation in advanced treatment Gas stripping – Analysis of gas stripping – Design of stripping towers – applications. – Air stripping of ammonia – Breakpoint chlorination – Ion exchange

UNIT – II	**NITROGEN REMOVAL AND OXIDATION PROCESSES**	**9 Periods**

Nutrient removal – Nitrogen removal – forms and sources of nitrogen – Biological nitrogen removal – Nitrification kinetics – Denitrification kinetics – Design parameters – Nitrogen removal by – physical and chemical processes Oxidation processes-advanced oxidation process in removal of nitrogen and phosphorus derivatives-use of peroxy, Cl- and oxy radicals in reducing COD.

UNIT – III	**MEMBRANE SEPARTION PROCESSES AND ELECTRO DIALYSIS**	**9 Periods**

Membrane separation processes – process classification – membrane materials-Symmetric and asymmetric membranes – membrane configuration – membrane fouling- Molecular weight cutoff – Reverse osmosis – theory – membrane structure and rejection mechanism – osmotic pressure – Transport models and flux equations – ultra filtration – Electrodialysis – theory – power requirement.

UNIT – IV	**PHOSPHOROUS REMOVAL**	**9 Periods**

Phosphorous removal – By biological methods – Phosphorous removal by chemical addition – chemistry of precipitation with Aluminium, calcium and Iron – Comparison of processes – Estimation of sludge produced from chemical precipitation of phosphorous with lime in PST.

UNIT – V	**WASTEWATER RECLAIMATION AND REUSE**	**9 Periods**

Merits and demerits of advanced treatment-applications of treated wastewater- Wastewater reclamation and reuse – The role of water recycling in the hydrologic cycle – wastewater reuse applications – public health and environmental issues in water reuse – Level of treatment – Risk Assessment – Ground water recharge with reclaimed water.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Waste Water Engineering – Treatment and reuse",*** *Metcalf and Eddy, Fourth Edition, McGraw Hill Education, 2017.*
2	***"Waste Water Treatment and disposal",*** *Arceivala S. J., Marcel dekker publishers,1981.*
3	***"Environmental Engineering",*** *Howard S. Peavy, Donald R. Rowe and George Techobanoglous, McGraw Hill Education, 2017.*
4	***"Wastewater Treatment Plant – Planning, Design and operation",*** *QASIM S. R, Holt Rinchart and Winston, New York, 2002.*
5	***"Biological Process Design for Wastewater Treatment",*** *Larry D. Benefield and Clifford W. Randall, Prentice - Hall Series in Environmental sciences, 1985.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Impart knowledge on advanced waste water treatment	K2
CO2	Understanding about Nitrogen removal and oxidation process	K3
CO3	Gain knowledge about membrane separation processes and Electro Dialysis	K3
CO4	Understanding about Phosphorus removal.	K2
CO5	Knowledge about impact of wastewater reclamation and reuse	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	2	3
CO2	2	1	1	3	2	2
CO3	3	3	2	2	1	3
CO4	2	1	1	3	2	2
CO5	3	2	3	1	1	2
23EEPE16	3	3	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	35	20	20	5	5	100
CAT2	15	25	30	20	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	25	15	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	15	35	20	20	5	5	100

23EEPE17	MARINE POLLUTION AND CONTROL					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objectives	• To understand the concept of marine and coastal environment. • To know the elements of hydrodynamics. • To identify the sources of marine pollution and control methods.

UNIT – I	**MARINE AND COASTAL ENVIRONMENT**	**9 Periods**

Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features – beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes–the oceans and climate, coastal zone regulation in India- national and international treaties.

UNIT – II	**OCEAN HYDRODYNAMICS**	**9 Periods**

Wave theory, waves in shallow waters – refraction, diffraction and shoaling, approximations for deep and shallow water conditions – tidal classification - general circulation of ocean waters -ocean currents - coastal sediment transport - onshore offshore sediment transport – beach formation and coastal processes - Tsunamis, storm surge, El Nino effect.

UNIT – III	**MARINE POLLUTION**	**9 Periods**

Sources of marine pollution – point and non-point sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbour activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter - effects of marine pollution on marine water quality and coastal ecosystems.

UNIT – IV	**MARINE POLLUTION MONITORING**	**9 Periods**

Basic measurements - sounding boat, echo sounders – current meters - tide gauge - use of GPS – measurement of coastal water characteristics – sea bed sampling – modelling of pollutant transport and dispersion - oil spill models - ocean monitoring satellites – applications of remote sensing and GIS in monitoring marine pollution – online marine pollution monitoring.

UNIT – V	**MARINE POLLUTION CONTROL MEASURES**	**9 Periods**

Marine discharges and effluent standards, pollution control strategies – marine outfall design – selection of optimal marine outfall locations - Total Maximum Daily Load (TMDL) applications –protocols in marine pollution control– Integrated Coastal Zone Management (ICZM) and sustainable development.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Marine pollution",*** *christopherl.j.frid, bryony a. Saswell, 2019.*
2	***"Marine pollution and climate change",*** *Andres Hugo Arias, Jorge Eduardo, Crc Pres, 2017.*
3	***"Marine Pollution, Shipping waste and International law",*** *Gabriela Arghello, Taylor & Francis Ltd, 2019.*
4	***"Marine Pollution: Sources, Fate & Effects of pollutants in coastal Ecosystems",*** *RichardoBeiras, 2018.*
5	***"Marine Pollution: Sources, Fate & Effects of pollutants in coastal Ecosystems",*** *RichardoBeiras, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the structures of marine environment.	K2
CO2	Interpret the onshore, offshore hydrodynamics.	K2
CO3	Categorize the marine pollution sources and effects.	K3
CO4	Familiarize the methods of monitoring used in marine environment.	K3
CO5	Correlate the marine pollution control strategies	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	2	1
CO2	3	3	2	2	2	1
CO3	3	3	2	2	2	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3
23EEPE17	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	20	40	10	-	-	100
CAT2	30	20	40	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	10	20	40	30	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	10	20	40	30	-	-	100
ESE	30	20	40	10	-	-	100

23EEPE18	GEO–ENVIRONMENTAL ENGINEERING					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To emphasize the need on geo environmental engineering and creating the awareness on safe disposal of waste by waste stabilization.					
UNIT – I	**GENERATION OF WASTES AND CONSEQUENCES OF SOIL POLLUTION**		**9 Periods**			
Introduction to Geo environmental engineering – Environmental cycle – Sources, production and classification of waste – Causes of soil pollution – Factors governing soil pollution interaction clay minerals - Failures of foundation due to waste movement.						
UNIT – II	**SITE SELECTION AND SAFE DISPOSAL OF WASTE**		**9 Periods**			
Safe disposal of waste – Site selection for landfills – Characterization of land fill sites and waste – Risk assessment – Stability of landfills – Current practice of waste disposal – Monitoring facilities – Passive containment system – Application of geosynthetics in solid waste management – Rigid or flexible liners.						
UNIT – III	**TRANSPORT OF CONTAMINANTS**		**9 Periods**			
Contaminant transport in sub surface – Advection, Diffusion, Dispersion – Governing equations – Contaminant transformation – Sorption – Biodegradation – Ion exchange – Precipitation – Hydrological consideration in land fill design – Ground water pollution.						
UNIT – IV	**WASTE STABILIZATION**		**9 Periods**			
Stabilization - Solidification of wastes – Micro and macro encapsulation – Absorption, Adsorption, Precipitation – Detoxification – Mechanism of stabilization – Organic and inorganic stabilization – Utilization of solid waste for soil improvement – case studies.						
UNIT – V	**REMEDIATION OF CONTAMINATED SOILS**		**9 Periods**			
Ex-situ and In-situ remediation-Solidification, bio-remediation, incineration, soil washing, phyto remediation, soil heating, vitrification, bio-venting.						
Contact Periods: **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***"Geo-Environmental Engineering"*** *Hari D. Sharma and Krishna R. Reddy, –John Wiley and Sons, INC, USA, 2004.*
2	***"Geotechnical Practice for waste disposal"*** *Daniel B.E., Chapman & Hall, London 1993.*
3	***"Waste Disposal in Engineered landfills"*** *Manoj Datta Narosa Publishing House, 1997.*
4	***"Industrial Solid Waste Management and Landfilling Practice"*** *Manoj Datta, B.P. Parida, B.K. Guha, Narosa Publishing House, 1999.WEF, Membrane Bioreactors, WEF manual of Practice No.36, Water Environment Federation, USA.2012.*
5	***"Environmental indices, Theory and Practice"*** *Ott, W.R., Ann Arbor, 1978.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Implement the geo environment technology	K3
CO2	Execute various practices of safe disposal of waste	K3
CO3	Perform waste audit and evaluate carbon footprint to achieve sustainable development.	K3
CO4	Examine the waste stabilization. Case study.	K3
CO5	Apply the remediation of contaminated soil	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	1
CO2	3	2	2	3	3	1
CO3	3	3	2	3	3	1
CO4	3	2	2	3	3	3
CO5	3	2	2	3	3	1
23EEPE18	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	40	15	10	5	5	100
CAT2	25	30	25	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE19	MEMBRANE SEPARATION PROCESSES FOR WATER AND WASTEWATER TREATMENT				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	• Acquire in-depth knowledge in the areas of membrane separation mechanisms, transport models, membrane permeability computations, membrane types and modules, membrane contactors / reactors and applications • Develop skills in applying transport models for the calculation of membrane permeability, flux, and the extent of separation for various membrane separation systems. • Be able to determine the types of experimental data needed for the calculation of membrane permeability parameters • To be able to calculate membrane process performance and analyze membrane separation characteristics • Be able to select membrane processes for solving separation problems in various applications.

UNIT – I	**INTRODUCTION**	**9 Periods**

Historical Development of membranes – classification of membrane and membrane processes – Structure and functions of symmetric and asymmetric membranes - Physical and chemical properties of membranes - Advantages– Membrane materials – Membrane modules and its types – Techniques of membrane preparation - membrane characterization – characterization of porous and non-porous membrane

UNIT – II	**TRANSPORT OF MEMBRANE**	**9 Periods**

Membrane transport theory- The solution-diffusion model – Structure-permeability relationships in solution diffusion membranes – Pore-flow membrane. Facilitated transport: Mechanism of facilitated transport – Coupled transport, carrier agents, competitive facilitated transport with two permeants, active and passive transport, potential applications of facilitated transport.

UNIT – III	**INDUSTRIAL MEMBRANE PROCESSES: THEORY AND DEISGN**	**9 Periods**

Reverse Osmosis – Pressure driven membrane processes: Introduction, Microfiltration - Membranes for microfiltration, Industrial applications. Ultrafiltration – membranes for ultrafiltration – Industrial applications. Reverse osmosis and nanofiltration – membranes for RO and Nanofiltration, Industrial applications. Electrically Driven Processes: Introduction – electrodialysis, Process parameters, Membranes for electrodialysis, applications – membrane electrolysis, Bipolar membranes, Fuel cells

UNIT – IV	**MEMBRANE GAS SEPARATION**	**9 Periods**

Gas separation – gas separation of porous and non-porous membranes- membranes for gas separation – Application – membranes for pervaporation – applications. Dialysis: membrane for dialysis – applications. Liquid membranes: Benefits – Bulk liquid membrane – Emulsion liquid membrane – Thin sheet supported liquid membrane – Hollow fiber supported liquid membrane – Application. Choices of organic solvent and carrier - Applications – Introduction to membrane reactors.

UNIT – V	**MEMBRANE FOULING AND ADVANCED MEMBRANE TECHNOLOGY**	**9 Periods**

Membrane Fouling – concept – types – factors responsible for fouling (Temperature, pressure, materials used for fouling, Concentration of feed) – Reversible and Irreversible fouling – Effect of fouling. Concept of bio-fouling – Effects and control. Economics of membrane – Feasibility of membrane – Membrane bioreactor – distillation: principle, construction, working – concept of Ion exchange: cations and anion exchange resins.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES

1	***"Membrane Processes for water reuse"*** Anthony Wachinski, , McGraw-Hill, USA, 2013
2	***"Membrane technology and applications"***, Baker, R.W., 2nd., John Wiley 2004
3	Jorgen Wagner, ***"Membrane Filtration handbook"***, *Practical Tips and Hints*, 2nd Edition, Revision 2, Osmonics Inc., 2001.
4	***"Membrane Separations Technology: Principles and Applications"*** Noble, R.D. and Stern, S.A., Elservier, Netherlands, 1995.
5	***"Membrane Technology in Environmental management"*** Yamamoto K. and Urase T, special issue, Water Science and technology, Vol.41, IWA Publishing, 2000
6	***"Membrane Bioreactors"*** WEF, *WEF manual of Practice No.36*, Water Environment Federation, USA.2012.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply various transport models for the calculation of membrane fluxes and the extent of separation for various membrane systems.	K3
CO2	Identify the types of experimental data needed for the calculation of membrane parameters	K3
CO3	Select a membrane process and design components to carry out a specific separation	K3
CO4	Apply advanced membrane techniques to solve environmental as well as chemical industries problems.	K3
CO5	Review the importance and relevance of separation process with the help of membrane in industry	K3

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	3	3
CO2	3	2	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	2	2	3	3	2
CO5	3	2	2	3	3	2
23EEPE19	3	3	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE20	ENVIRONMENTAL POLICY AND LEGISLATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To discuss the environmental policies and recalling the environmental movements in India. In additional to enumerate the international environmental treaties.

UNIT – I	EVOLUTION OF INTERNATIONAL ENVIRONMENTAL POLICY	9 Periods

Fundamental principles of environmental protection - sustainable development- Brundtland report 1987. Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle, Public Trust Doctrine. Constitutional Perspective: Fundamental right to wholesome environment. Directive principles of state policy. Fundamental duty. National Environmental Policy. Environmental Regulatory Framework in India. Role of International Environmental Agencies -UNEP, GEF, UNFCC and IPCC.

UNIT – II	ENVIRONMENTAL MOVEMENT IN INDIA	9 Periods

Movements related to Environment Sacred groves, Bishnoi tradition, Chipko movement, Tehridam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley,Span motels private limited case, Oleum gas case.

UNIT – III	INTERNATIONAL ENVIRONMENTAL TREATIES AND CONVENTIONS	9 Periods

Stockholm conference on human environment, 1972, Ramsar Convention on Wetlands, 1971, Montreal Protocol, 1987, Basel Convention (1989,1992), Earth summit at rio de janeiro, 1992, Kyoto Protocol, 1997, Earth summit at johannesburg, 2002. Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 22 Convention on Desertification 1996, Convention on Biodiversity & Cartagena Protocol on Bio safety.

UNIT – IV	OBJECTIVES AND PROVISIONS OF ACTS AND RULES I	9 Periods

Indian Forest Act 1927, Indian Wildlife (Protection) Act, 1972, Forest Conservation Act 1980, Forest Rights Act, Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act 1981, Environment (Protection) Act, 1986, Public Liability insuranceact,1991, Noise Pollution (Regulation and Control) Rules, 2000.

UNIT – V	OBJECTIVES AND PROVISIONS OF ACTS AND RULES II	9 Periods

Bio-Medical Waste (Management & Handling) Rules, 1998, Recycled Plastics Manufacture and Usage Rules, 1999, Municipal Solid Waste (Management and Handling Rules) 2000, Biodiversity Act 2002, Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003, EIA Notification 2006, The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, Wetland Rules 2009, National Green Tribunal Act 2010, Coastal Regulation Zones (CRZ) Rules 2011. E-waste Management and Handling Rules 2011, Plastics Manufacture, Sale and Usage Rules, 2011.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	***"Environmental Law and Policy in India",*** *Shyam Divan and Armin Rosencranz, Oxford University Press, New Delhi, 2005.*
2	***"Environmental Law Case Book, Lexis Nexis, Butterworths, Mohanty",*** *S. K.,Leelakrishnan. P, Environment and Pollution Law, Universal Law Publishing Co.Pvt. Ltd., 2011.*
3	***"Environmental Law, (2nd Edn.)",*** *Shastri S C, Eastern Book Company, Lucknow, 2008.*
4	***"Environmental Law in India",*** *Singh Gurdip, Mcmillan& Co., 2004,*
5	***"Introduction to Environmental Law",*** *Shantakumar S, (2nd Edn.), Wadhwa & Company, Nagpur, 2005.*
6	***"Handbook of Environmental Law in India",*** *Sahasranaman P B, Oxford University Press (India), 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Demonstrate the evolution of International Environmental Policies.	K3
CO2	Recall environmental movements in India	K3
CO3	Discuss the International Environmental Policies	K3
CO4	Underline the act and rules I	K3
CO5	Accentuate the objective and provisions of act and rules II	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	2	3	3	1
CO2	3	3	2	3	2	1
CO3	3	2	3	2	2	1
CO4	2	3	3	2	3	1
CO5	3	2	3	2	3	1
23EEPE20	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	25	25	15	15	-	100
CAT2	20	20	25	20	15	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	30	35	20	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	25	25	-	100
ESE	20	25	25	10	20	-	100

23EEPE21	INSTRUMENTATION, SELECTION AND MANAGEMENT OF ENVIRONMENTAL ENGINEERING EQUIPMENTS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on maintenance of machineries and analytical instruments used in water and waste water machineries and equipments addition to gain knowledge on equipments in air pollution control					
UNIT – I	**GENERAL**		**9 Periods**			
Study of machinery, electric motors types and characteristics, other prime covers, pumps, capacity, operation and maintenance of pumping machinery, air compressors preventive maintenance, break-down maintenance, schedules – Factors to be considered in the selection of the equipment.						
UNIT – II	**INSTRUMENTATION**		**9 Periods**			
pH meter - Flame Emission Spectrometry. Absorption spectrometry - Nephelometry – Atomic Absorption Spectrometry - Gas chromatography – working principle and components. Total carbon analyser Mercury Analyser polar graph for metal estimation and organic compounds – Ion selective Electrode -SO2 and CO analyser – Instrument components and its working principle						
UNIT – III	**WATER SUPPLY MACHINERY AND WASTEWATER MACHINERY**		**9 Periods**			
Drilling equipment, pumping equipment for wells. Machinery required for primary and secondary treatment, sewage pumps, sludge pumps, vacuum filtration equipment						
UNIT – IV	**EQUIPMENTS FOR TREATMENT UNITS**		**9 Periods**			
Equipment for treatment unit - electrically and mechanically operated agitators, mixers, aerators, chlorinators, Surface aerators. Meters for measurement of flow, head, and electricity.						
UNIT – V	**AIR POLLUTION CONTROL EQUIPMENTS**		**9 Periods**			
Working principles of electrostatic precipitator – cyclone separators – settling chamber –operation and Maintenance. Machinery for solid waste collection and disposal incineration –compactors – magnetic separators- incinerators.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*Operation and Control of Water Treatment Processes COX CR WHO 1969.*
2	*Course Manual on Preventive Maintenance of Water Distribution System, NEERI,1993.*
3	***"Environmental Engineering",*** *Howard Peavy, Donald Rowe & George Tchobanoglous, McGraw Hill publication, 2017.*
4	***Introduction to instrumentation measurements and field methods in environmental science,*** *Ekanade Olusegun, Edward C. Orji, JariSanusiI, National Open University of Nigeria Publications, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate handling and maintenance of water and waste water machineries and equipment	K3
CO2	Demonstrate the principle and operation of various Analytical Instruments.	K3
CO3	Explain the operation of water and wastewater machineries	K3
CO4	Select suitable equipment to be used in treatment units.	K3
CO5	Explain the various equipments used in air pollution control	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	1
CO2	2	3	1	1	2	1
CO3	2	3	1	1	2	1
CO4	1	3	1	1	2	1
CO5	1	3	1	1	2	1
23EEPE21	2	3	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEPE22	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	Imparting knowledge of Environmental chemistry and microbiology and emphasising the need on sustainable development with help of microorganism culture.					
UNIT – I	**BASIC PRINCIPLES OF ANALYTICAL CHEMISTRY**					**9 Periods**
Concentration of solutions-Calculations - Ionic equilibrium of weak electrolytes, – common ion effect – Buffer Solutions-Change of pH with salt concentrations, Buffer Index-Solubility product, Hydrolysis of salts – Oxidation and Reduction reactions stoichiometry.						
UNIT – II	**CHEMICAL KINETICS**					**9 Periods**
Rate constants of first and second-order reactions – problems – effect of temperature on reaction rates – Derivation of Arrhenius equation – problems – consecutive reactions – basic concepts of enzymes, cofactors – enzyme catalyzed reactions – Temperature dependence of enzyme activity– Enzyme kinetics- Michalei's Menton equation – significance.						
UNIT – III	**AQUATIC AND SOIL CHEMISTRY**					**9 Periods**
Precipitation and dissolution- Water softening and water conditioning- Complexation of metal ions and organic complexes in natural water- Weathering reactions- Structure and surface reactions of clays and oxides- Forces at soil water interfaces.						
UNIT – IV	**INTRODUCTION TO MICROBIOLOGY**					**9 Periods**
Classification of microorganisms. Culture of micro-organisms- media preparation, sterilization, pure culture, maintenance of cultures. Culturing methods- Streaking, Pour plate, Spread plate. Growth curve - factors affecting growth, nutritional requirements of micro-organisms –Microbial metabolism- Respiration and energy generation.						
UNIT – V	**IMPACT OF MICROBES ON ENVIRONMENT & HEALTH**					**9 Periods**
Eutrophication. Role of Microbes in Carbon, Phosphorus, Nitrogen and Sulphur cycles. Microbe induced Corrosion and Leaching – Xenobiotics. Waterborne diseases and their causative organisms. Differentiation of faecal & non-faecal coliforms-tests for the presence of coliform organisms-presumptive, confirmed and completed test, MPN index, use of Millipore filter technique, standards for bacteriological quality.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	***Microbiology,*** *Pelczar. Jr.M.J., Chan, E.C.S., Krieg.R. Noel., and PelczarMernaFoss, 5th Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2004.*
2	***Prescott's Microbiology,*** *Joanne Willey Kathleen Sandman and Dorothy Wood.,11th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2020.*
3	***Hand Book of Environmental Microbiology*** *S.C. Bhatia, 3rd Edition, Atlantic Publishers and Distributors, 2008.*
4	***Environmental Microbiology,*** *Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier, 3rd Edition, Academic Press, 2014.*
5	***Essentials Of Ecology & Environmental Science****, S. V. S. Rana, 5th Edition, PHI Learning Press, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Impart knowledge on basic principles of Analytic chemistry	K1
CO2	Execute various practices of chemical kinetics.	K2
CO3	Investigating aquatic and soil chemistry	K3
CO4	Understanding about Microbiology.	K2
CO5	Knowledge about impact of microbes on Environment and Health	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	2	2	3
CO2	3	2	3	1	2	2
CO3	2	3	3	2	3	3
CO4	3	2	3	2	2	2
CO5	3	1	2	2	1	3
23EEPE22	3	3	3	2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	35	30	10	5	5	100
CAT2	15	35	20	20	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	10	40	35	15	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23SEOE01	BUILDING BYE-LAWS AND CODES OF PRACTICE (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on the building bye –laws and to emphasize the significance of codes of practice in construction sector.					
UNIT – I	**INTRODUCTION TO BUILDING BYE-LAWS**					**9 Periods**
Introduction to Building Bye Laws and regulation, their need and relevance, General definitions such as building height, building line, FAR, Ground Coverage, set back line. Introduction to Master Plan and understanding various land uses like institutional, residential etc. - Terminologies of Building bye-laws.						
UNIT – II	**ROLE OF STATUTORY BODIES**					**9 Periods**
Role of various statutory bodies governing building works like development authorities, municipal corporations etc. Local Planning Authority, Town and Country planning organisation, Ministry of urban development.						
UNIT – III	**APPLICATION OF BUILDING BYE-LAWS**					**9 Periods**
Interpretation of information given in bye laws including ongoing changes as shown in various annexure and appendices. Application of Bye-laws like structural safety, fire safety, earthquake safety, basement, electricity, water, and communication lines in various building types.						
UNIT – IV	**INTRODUCTION TO CODES OF PRACTICE**					**9 Periods**
Introduction to various building codes in professional practice - Codes, regulations to protect public health, safety and welfare - Codes, regulations to ensure compliance with the local authority.						
UNIT – V	**APPLICATION OF CODES OF PRACTICE**					**9 Periods**
Applications of various codes as per various building types. Bureau of Indian Standards, Eurocode – Introduction to other international codes.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES :

1	***"National Building Code of India 2016 – SP 7",*** *NBC 2016, Bureau of Indian Standards.*
2	***"Model Building Bye-Laws (MBBL) – 2016",*** *Town and Country Planning Organization, Ministry of Housing and Urban Affairs, Government of India.*
3	***"Unified Building Bye-laws for Delhi 2016",*** *Nabhi Publications, 2017.*
4	Mukesh *Mittal,* ***"Building Bye Laws",*** *Graphicart publishers, Jaipur, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the building bye-laws in planning, design and construction works.	K3
CO2	Familiarize with the role of various statutory bodies.	K2
CO3	Execute safety related work practices in the construction sector.	K3
CO4	Ensure compliance with the rules and regulations in design and construction practices.	K3
CO5	Perform design and construction practices based on national and international codal provisions.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	3
CO2	1	3	1	1	2	3
CO3	1	3	1	1	2	3
CO4	2	3	1	1	2	3
CO5	2	3	1	1	2	3
23SEOE01	2	3	1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23SEOE02	PLANNING OF SMART CITIES (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.					
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**					**9 Periods**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.						
UNIT – II	**SUSTAINABLE URBAN PLANNING**					**9 Periods**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.						
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**					**9 Periods**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.						
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**					**9 Periods**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.						
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**					**9 Periods**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Poonam Sharma, Swati Rajput,* ***"Sustainable Smart Cities In India Challenges And Future Perspectives"****, Springer 2017 Co.(P) Ltd. 2013.*
2	*Ivan Nunes Da Silva,* ***"Rogerio Andrade Flauzino-Smart Cities Technologies-Exli4eva"****, 2016.*
3	*Stan McClellan, Jesus A. Jimenez, George Koutitas* ***"Smart Cities_ Applications, Technologies, Standards"****, and Driving Factors-Springer International Publishing, 2018.*
4	*Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell,* ***"Planning Support Systems And Smart Cities"****, Springer, 2015.*
5	*Pradip Kumar Sarkar and Amit Kumar Jain* ***"Intelligent Transport Systems"****, PHI Learning, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Indicate the potential challenges in smart city development.	K2
CO2	Select the different tools for sustainable urban planning.	K3
CO3	Choose appropriate energy conservation system for smart cities.	K3
CO4	Identify the proper method of water management system.	K3
CO5	Apply Intelligent Transport System concepts in planning of smart city.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3	1	1
CO2	1	1	1	3	2	1
CO3	1	1	-	2	2	1
CO4	1	-	1	2	1	1
CO5	1	-	1	3	1	-
23SEOE02	1	1	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	45	30	-	-	-	100
CAT2	25	45	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	15	40	45	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	45	45	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEOE03	GREEN BUILDING (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To introduce the different concepts of energy efficient buildings, indoor environmental quality management, green buildings and its design.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials.		
UNIT – II	**ENERGY EFFICIENT BUILDINGS**	**9 Periods**
Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards-Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.		
UNIT – III	**INDOOR ENVIRONMENTAL QUALITY MANAGEMENT**	**9 Periods**
Psychrometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.		
UNIT – IV	**GREEN BUILDING CONCEPTS**	**9 Periods**
Green building concept- Green building rating tools- Leeds and IGBC codes. – Material selection Embodied energy- Operating energy- Façade systems- Ventilation systems-Transportation- Water treatment systems- Water efficiency- Building economics		
UNIT – V	**GREEN BUILDING DESIGN - CASE STUDY**	**9 Periods**
Case studies - Building form, orientation and site considerations; conservation measures; energy modeling; heating system and fuel choices; renewable energy systems; material choices - construction budget		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES :

1	*Sam Kubba* ***"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes",*** *, Elsevier Science, 2012.*
2	*Yudelson, Jerry, McGraw-Hill,* ***"Greening existing buildings",*** *New York, 2010*
3	*Charles J. Kibert, John Wiley & Sons,* ***"Sustainable Construction: Green Building Design and Delivery****", 3rd Edition, 2012*
4	*R.S. Means, John Wiley & Sons,* ***"Green Building: Project Planning & Cost Estimating",*** *2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of sustainable design in building construction.	K3
CO2	Execute green building techniques including energy efficiency management in the building design.	K3
CO3	Establish indoor environmental quality in green building.	K3
CO4	Perform the green building rating using various tools.	K3
CO5	Create drawings and models of green buildings.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	2	2	2	2	3	3
CO4	2	3	1	3	3	3
CO5	3	3	1	3	3	3
23SEOE03	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23EEOE04	ENVIRONMENT HEALTH AND SAFETY MANAGEMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on occupational health hazards, safety measures at work place, accident prevention, safety management and safety measures in industries.

UNIT – I	**OCCUPATIONAL HEALTH HAZARDS**	**9 Periods**

Occupation, Health and Hazards - Safety Health and Management: Occupational Health Hazards - Ergonomics - Importance of Industrial Safety - Radiation and Industrial Hazards: Types and effects - Vibration - Industrial Hygiene - Different air pollutants in industries and their effects - Electrical, fire and Other Hazards.

UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**

Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance - Housekeeping, Industrial lighting, Vibration and Noise.

UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**

Accident Prevention Techniques - Principles of accident prevention - Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid: Body structure and functions - Fracture and Dislocation, Injuries to various body parts.

UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**

Safety Management System and Law - Legislative measures in Industrial Safety - Occupational safety, Health and Environment Management, Bureau of Indian Standards on Health and Safety, IS 14489 standards - OSHA, Process safety management (PSM) and its principles - EPA standards

UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**

Plant Layout for Safety - design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System - Significance of Documentation - Case studies involving implementation of health and safety measures in Industries.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	***"Physical Hazards of the Workplace"**, Barry Spurlock, CRC Press, 2017.*
2	***"Handbook of Occupational Safety and Health",** S. Z. Mansdorf, Wiley Publications,2019*
3	***"Safety, Health, and Environment"**, NAPTA, 2nd Edition, Pearson Publications, 2019.*
4	*"**Occupational Health and Hygiene in Industries**", Raja Sekhar Mamillapalli, Visweswara Rao , PharmaMed Press, 1st edition, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the occupational health hazards.	K3
CO2	Execute various safety measures at workplace.	K3
CO3	Analyze and execute accident prevention techniques.	K3
CO4	Implement safety management as per various standards.	K3
CO5	Develop awareness on safety measures in Industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	3	2
CO2	2	2	2	1	2	2
CO3	2	3	2	1	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	1	1	2
23EEOE04	1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEOE05	CLIMATE CHANGE AND ADAPTATION (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.	
UNIT – I	**EARTH'S CLIMATE SYSTEM**	**9 Periods**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification- Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.		
UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**	**9 Periods**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.		
UNIT – III	**IMPACTS OF CLIMATE CHANGE**	**9 Periods**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios –Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.		
UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**	**9 Periods**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry –Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.		
UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**	**9 Periods**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology –Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0Periods** **Practical: 0 Periods** **Total:45 Periods**		

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",****2007*
4	*IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability"****, 2007*
5	*IPCC fourth assessment report – Working Group III Report"* ***Mitigation of Climate Change",*** *2007*
6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify the Earths climatic system and factors causing climate change and global warming.	K2
CO2	Relate the Changes in patterns of temperature, precipitation and sea level rise and Observed effects of Climate Changes	K2
CO3	Illustrate the uncertainty and impact of climate change and risk of reversible changes.	K3
CO4	Articulate the strategies for adaptation and mitigation of climatic changes.	K3
CO5	Discover clean technologies and alternate energy source for sustainable growth.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	3	1
CO2	3	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	3	2	2	2	2	2
CO5	3	3	2	3	3	3
23EEOE05	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEOE06	WASTE TO ENERGY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To classify waste as fuel, introduce conversion devices, gain knowledge about Biomass Pyrolysis, demonstrate methods, factors for biomass gasification, and acquire knowledge about biogas and its development in India.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, Gasifiers, Digestors.						
UNIT – II	**BIOMASS PYROLYSIS**					**9 Periods**
Biomass Pyrolysis: Pyrolysis -Types, Slow Pyrolysis, Fast Pyrolysis – Manufacture of charcoal – Methods – Yields and Applications – Manufacture of Pyrolytic oils and gases, Yields and Applications.						
UNIT – III	**BIOMASS GASIFICATION**					**9 Periods**
Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, Construction and Operation – Gasifier burner arrangement for thermal heating – Gasifier Engine arrangement and electrical power – Equilibrium and Kinetic Considerations in gasifier operation.						
UNIT – IV	**BIOMASS COMBUSTION**					**9 Periods**
Biomass Combustion – Biomass Stoves – Improved Chullahs, types, some exotic designs, Fixed bed combustors, types – Inclined grate combustors – Fluidized bed combustors, design, construction and operation of all the above biomass combustors.						
UNIT – V	**BIOENERGY SYSTEM**					**9 Periods**
Biogas: Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification - Biomass conversion processes – Thermo chemical conversion – Direct combustion – biomass gasification – pyrolysis and liquefaction – biochemical conversion – anaerobic digestion – Types of biogas plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	***"Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies",*** *P Jayaram Reddy, Taylor and Francis Publications, 2016.*
2	***"Waste – to – Energy: Technologies and project Implementations",*** *Marc J Rogoff, Francois Screve,ELSEVIER Publications, Third Edition, 2019.*
3	***"Biogas Technology and Principles"****, Brad Hill, NY RESEARCH PRESS Publications, Illustrated Edition, 2015.*
4	***"Biomass Gasification and Pyrolysis Practical Design and Theory"****,* Prabir*ELSEVIER Publications, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Investigate solid waste management techniques.	K2
CO2	Get knowledge about biomass pyrolysis.	K3
CO3	Demonstrate methods and factors considered for biomass gasification.	K3
CO4	Identify the features of different facilities available for biomass combustion.	K4
CO5	Analyze the potential of different Bioenergy systems with respect to Indian condition.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	1
CO2	3	2	2	2	3	1
CO3	3	3	2	3	2	1
CO4	3	2	2	3	3	1
CO5	2	3	3	3	2	1
23EEOE06	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	20	25	15	10	100
CAT2	10	25	20	10	25	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	35	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	50	-	-	100
ESE	10	25	25	20	10	10	100

23GEOE07	ENERGY IN BUILT ENVIRONMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To understand constructional energy requirements of buildings, energy audit methods and conservation of energy.					
UNIT–I	**INTRODUCTION**					**9 Periods**
Indoor activities and environmental control - Internal and external factors on energy use –Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications –Thermal comfort-Ventilation and air quality-Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.						
UNIT–II	**LIGHTING REQUIREMENTS IN BUILDING**					**9 Periods**
The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings–Lighting and day lighting : Characteristics and estimation, methods of day-lighting–Architectural considerations for day-lighting.						
UNIT–III	**ENERGY REQUIREMENTS IN BUILDING**					**9 Periods**
Steady and unsteady heat transfer through wall and glazed window-Standards for thermal performance of building envelope- Evaluation of the overall thermal transfer- Thermal gain and net heat gain-End-Use energy requirements-Status of energy use in buildings-Estimation of energy use in a building.						
UNIT–IV	**ENERGY AUDIT**					**9 Periods**
Energy audit and energy targeting-Technological options for energy management-Natural and forced ventilation–Indoor environment and air quality-Air flow and air pressure on buildings-Flow due to Stack effect.						
UNIT–V	**COOLING IN BUILT ENVIRONMENT**					**9 Periods**
Passive building architecture– Radiative cooling-Solar cooling techniques-Solar desiccant dehumidification for ventilation-Natural and active cooling with adaptive comfort–Evaporative cooling – Zero energy building concept.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*J.Krieder and A.Rabl**, "Heating and Cooling of Buildings: Design for Efficiency"**, McGraw-Hill, 2000.*
2	*S.M.Guinnes and Reynolds, "**Mechanical and Electrical Equipment for Buildings"**,Wiley, 1989.*
3	*A.Shaw, "**Energy Design for Architects"**, AEE Energy Books, 1991.*
4	*ASHRAE,"**Hand book of Fundamentals"**,ASHRAE,Atlanta,GA.,2001.*
5	*Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinoi ,USA.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand energy and its usage	K2
CO2	Know lighting to be given to a building	K1
CO3	Analyse the energy requirements in a building	K3
CO4	Apply the energy audit concepts.	K3
CO5	Study architectural specifications of a building	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23GEOE07	2	-	3	1	2	1
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE08	EARTH AND ITS ENVIRONMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To know about the planet earth, the geosystems and the resources like ground water and air and to learn about the Environmental Assessment and sustainability.					
UNIT–I	**EVOLUTION OF EARTH**					**9 Periods**
Evolution of earth as habitable planet-Evolution of continents-oceans and landforms-evolution of life through geological times - Exploring the earth's interior - thermal and chemical structure - origin of gravitational and magnetic fields.						
UNIT–II	**GEOSYSTEMS**					**9 Periods**
Plate tectonics - working and shaping the earth - Internal geosystems – earthquakes – volcanoes -climatic excursions through time - Basic Geological processes - igneous, sedimentation – metamorphic processes.						
UNIT–III	**GROUND WATER GEOLOGY**					**9 Periods**
Geology of ground water occurrence –recharge process-Ground water movement-Ground water discharge and catchment hydrology – Ground water as a resource - Natural ground water quality and contamination-Modelling and managing ground water systems.						
UNIT–IV	**ENVIRONMENTAL ASSESMENT AND SUSTAINABILITY**					**9 Periods**
Engineering and sustainable development - population and urbanization - toxic chemicals and finite resources - water scarcity and conflict - Environmental risk - risk assessment and characterization –hazard assessment-exposure assessment.						
UNIT–V	**AIR AND SOLIDWASTE**					**9 Periods**
Air resources engineering-introduction to atmospheric composition–behaviour-atmospheric photo chemistry-Solid waste management–characterization-management concepts.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*John Grotzinger and Thomas H.Jordan, "**Understanding Earth",** Sixth Edition, W.H.Freeman, 2010.*
2	*Younger,P.L., "**Ground water in the Environment: An introduction"**, Blackwell Publishing,2007.*
3	*Mihelcic, J. R., Zimmerman, J. B., "**Environmental Engineering:Fundamentals, Sustainability and Design"**,Wiley,NJ, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To know about evolution of earth and the structure of the earth.	K2
CO2	To understand the internal geosystems like earthquakes and volcanoes and the Various geological processes.	K2
CO3	To able to find the geological process of occurrence and movement of Ground water and the modeling systems.	K3
CO4	To assess the Environmental risks and the sustainability developments.	K3
CO5	To learn about the photochemistry of atmosphere and the solid waste Management concepts.	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	2	2	-
CO2	3	-	3	3	-	3
CO3	2	-	-	-	-	-
CO4	-	2	-	-	1	-
CO5	2	2	-	1	-	-
23GEOE08	2	2	3	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE09	NATURAL HAZARDS AND MITIGATION (Common to all Branches)				
PREREQUISITES:	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**
Course Objective	To get idea on the causes, effects and mitigation measures of different types of hazards with case studies.				
UNIT–I	**EARTH QUAKES**			**9 Periods**	
Definitions and basic concepts-different kinds of hazards–causes-Geologic Hazards–Earthquakes-causes of earthquakes–effects-plate tectonics-seismic waves-measures of size of earthquakes-earthquake resistant design concepts.					
UNIT–II	**SLOPE STABILITY**			**9 Periods**	
Slope stability and landslides-causes of landslides–principles of stability analysis-remedial and corrective measures for slope stabilization.					
UNIT–III	**FLOODS**			**9 Periods**	
Climatic Hazards–Floods-causes of flooding-regional flood frequency analysis–flood control measures-flood routing-flood forecasting-warning systems.					
UNIT–IV	**DROUGHTS**			**9 Periods**	
Droughts –causes - types of droughts –effects of drought -hazard assessment – decision making-Use of GIS in natural hazard assessment–mitigation-management.					
UNIT–V	**TSUNAMI**			**9 Periods**	
Tsunami–causes–effects–under sea earthquakes–landslides–volcanic eruptions–impact of sea meteorite–remedial measures–precautions–case studies.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**					

REFERENCES

1	*Donald Hyndman and David Hyndman, **"Natural Hazards and Disasters",** Brooks/Cole Cengage Learning, 2008.*
2	*Edward Bryant, **"Natural Hazards"**, Cambridge University Press,2005.*
3	*J Michael Duncan and Stephan G Wright, **"Soil Strength and Slope Stability"**, John Wiley & Sons, Inc,2005.*
4	*AmrS.Elnashai and Luigi Di Sarno,**"Fundamentals of Earthquake Engineering"**, John Wiley & Sons,Inc,2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the basic concepts of earthquakes and the design concepts of earthquake Resistant buildings.	K2
CO2	Acquire knowledge on the causes and remedial measures of slope stabilization.	K3
CO3	As certain the causes and control measures of flood.	K3
CO4	Know the types, causes and mitigation of droughts.	K2
CO5	Study the causes, effects and precautionary measures of Tsunami.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	2	3
CO2	3	1	2	3	3	3
CO3	3	2	3	-	-	3
CO4	3	-	-	3	2	3
CO5	3	-	2	2	-	3
23GEOE09	3	1	2	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23EDOE10	BUSINESS ANALYTICS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To apprehend the fundamentals of business analytics and its life cycle. • To gain knowledge about fundamental business analytics. • To study modeling for uncertainty and statistical inference. • To apprehend analytics the usage of Hadoop and Map Reduce frameworks. • To acquire insight on other analytical frameworks.

UNIT – I	**BUSINESS ANALYTICS AND PROCESS**	**9 Periods**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT – II	**REGRESSION ANALYSIS**	**9 Periods**

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT – III	**STRUCTURE OF BUSINESS ANALYTICS**	**9 Periods**

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT – IV	**FORECASTING TECHNIQUES**	**9 Periods**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT – V	**DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS**	**9 Periods**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical : 0Periods** **Total : 45 Periods**

REFERENCES

1	*VigneshPrajapati, **"Big Data Analytics with R and Hadoop",**Packt Publishing, 2013.*
2	*Umesh R Hodeghatta, UmeshaNayak**, "Business Analytics Using R – A Practical Approach",** Apress, 2017.*
3	*AnandRajaraman, Jeffrey David Ullman, **"Mining of Massive Datasets",** Cambridge University Press, 2012.*

4	*Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson,* ***"Essentials of Business Analytics",*** *Cengage Learning, second Edition, 2016.*
5	*U. Dinesh Kumar,* ***"Business Analytics: TheScience of Data-Driven Decision Making",*** *Wiley, 2017.*
6	*Rui Miguel Forte,* ***"Mastering Predictive Analytics with R",*** *Packt Publication, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the real world business problems and model with analytical solutions.	K4
CO2	Solve analytical problem with relevant mathematics background knowledge.	K4
CO3	Convert any real world decision making problem to hypothesis and apply suitable statistical testing.	K4
CO4	Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce	K4
CO5	Use open source frameworks for modeling and storing data.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	2	1
CO2	1	1	1	2	1
CO3	2	2	1	1	-
CO4	2	2	1	-	-
CO5	1	2	-	-	-
23EDOE10	1	2	1	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• Summarize basics of industrial safety. • Describe fundamentals of maintenance engineering. • Explain wear and corrosion. • Illustrate fault tracing. • Identify preventive and periodic maintenance.

UNIT – I	**INTRODUCTION**	**9 Periods**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT – II	**FUNDAMENTALS OF MAINTENANCE ENGINEERING**	**9 Periods**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT – III	**WEAR AND CORROSION AND THEIR PREVENTION**	**9 Periods**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – IV	**FAULT TRACING**	**9 Periods**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT – V	**PERIODIC AND PREVENTIVE MAINTENANCE**	**9 Periods**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical:0Periods** **Total:45 Periods**

REFERENCES

1	*Hans F. Winterkorn,* ***"Foundation Engineering Handbook",*** *Chapman & Hall London, 2013.*
2	***"Maintenance Engineering"*** *by Dr. Siddhartha Ray, New Age International (P) Ltd., Publishers, 2017*
3	***"Industrial Safety Management",*** *McGraw Hill Education; New edition (1 July 2017)*
4	***"Industrial Engineering And Production Management",*** *S. Chand Publishing; Third edition ,2018*
5	***"Industrial Safety and Maintenance Engineering",*** *Parth B. Shah, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to summarize basics of industrial safety	K4
CO2	Ability to describe fundamentals of maintenance engineering	K4
CO3	Ability to explain wear and corrosion	K4
CO4	Ability to illustrate fault tracing	K4
CO5	Ability to identify preventive and periodic maintenance	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23EDOE11	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE12	OPERATIONS RESEARCH (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• Solve linear programming problem and solve using graphical method. • Solve LPP using simplex method. • Solve transportation, assignment problems. • Solve project management problems. • Solve scheduling problems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT – II	**LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming		
UNIT – III	**NON-LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT		
UNIT – IV	**SEQUENCING AND INVENTORY MODEL**	**9 Periods**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT – V	**GAME THEORY**	**9 Periods**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		
Contact Periods: **Lecture: 45 Periods** **Tutorial : 0 Periods** **Practical : 0 Periods** **Total : 45 Periods**		

REFERENCES

1	*H.A. Taha **"Operations Research, An Introduction",** PHI, 2017.*
2	***"Industrial Engineering and Management",** O. P. Khanna, 2017.*
3	***"Operations Research",** S.K. Patel, 2017.*
4	***"Operation Research",**AnupGoel, RuchiAgarwal, Technical Publications, Jan 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate linear programming problem and solve using graphical method.	K4
CO2	Solve LPP using simplex method.	K4
CO3	Formulate and solve transportation, assignment problems.	K4
CO4	Solve project management problems.	K4
CO5	Solve scheduling problems	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	-
CO3	1	1	2	1	1
CO4	1	1	-	-	-
CO5	2	1	-	-	-
23EDOE12	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23MFOE13	OCCUPATIONAL HEATH AND SAFETY (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To gain knowledge about occupational health hazard and safety measures at work place. • To learn about accident prevention and safety management. • To learn about general safety measures in industries.

UNIT – I	**OCCUPATIONAL HEALTH AND HAZARDS**	**9 Periods**

Safety- History and development, National Safety Policy- Occupational Health Hazards - Ergonomics - Importance of Industrial Safety Radiation and Industrial Hazards- Machine Guards and its types, Automation.

UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**

Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance, Plant Design and Housekeeping, Industrial lighting, Vibration and Noise Case studies.

UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**

Accident Prevention Techniques - Principles of accident prevention - Definitions, Theories, Principles – Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid : Body structure and functions - Fracture and Dislocation, Injuries to various body parts.

UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**

Safety Management System and Law - Legislative measures in Industrial Safety: Various acts involved in Detail- Occupational safety, Health and Environment Management: Bureau of Indian Standards on Health and Safety, 14489, 15001 - OSHA, Process safety management (PSM) and its principles - EPA standards- Safety Management: Organisational & Safety Committee - its structure and functions.

UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**

Plant Layout for Safety -design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System: Significance of Documentation Directing Safety, Leadership -Case studies involving implementation of health and safety measures in Industries.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**

REFERENCES

1	*Benjamin O.Alli, **Fundamental Principles of Occupational Health and Safety** ILO 2008.*
2	*Danuta Koradecka, **Handbook of Occupational Health and Safety**, CRC, 2010.*
3	*Dr. Siddhartha Ray, **Maintenance Engineering,** New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M., **Industrial Safety Management**, 3rd Edition, Tata McGraw Hill, NewDelhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*
6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain the knowledge about occupational health hazard and safety measures at work place.	K3
CO2	Learn about accident prevention and safety management.	K2
CO3	Understand occupational health hazards and general safety measures in industries.	K3
CO4	Know various laws, standards and legislations.	K2
CO5	Implement safety and proper management of industries.	K4

COURSE ARTICULATION MATRIX:					
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23MFOE13	**2**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		50	50				100
CAT2		50	30	20			100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2		50	30	20			100
ESE		40	40	20			100

23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To understand the costing concepts and their role in decision making. • To acquire the project management concepts and their various aspects in selection. • To gain the knowledge in costing concepts with project execution. • To develop knowledge of costing techniques in service sector and various budgetary control techniques. • To familiarize with quantitative techniques in cost management.

UNIT – I	**INTRODUCTION TO COSTING CONCEPTS**	**9 Periods**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision - Making.

UNIT – II	**PROJECT PLANNING ACTIVITIES**	**9 Periods**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT – III	**COST ANALYSIS**	**9 Periods**

Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT – IV	**PRICING STRATEGIES AND BUDGETORY CONTROL**	**9 Periods**

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing, Costing of service sector, Just-in -time approach, Material Requirement Planning, Enterprise Resource Planning. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT – V	**TQM AND OPERATIONS REASEARCH TOOLS**	**9 Periods**

Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Charles T. Horngren and George Foster, **Advanced Management Accounting**, 2018.*
2	*John M. Nicholas,**Project Management for Engineering, Business and Technology**, Taylor &Francis, 2016*
3	*Nigel J, **Engineering Project Management**, John Wiley and Sons Ltd, Smith 2015.*
4	*Charles T. Horngren and George Foster **Cost Accounting a Managerial Emphasis**, Prentice Hall of India, New Delhi, 2011.*
5	*https://archive.nptel.ac.in/courses/110/104/110104073/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the costing concepts and their role in decision making.	K3
CO2	Apply the project management concepts and analyze their various aspects in selection.	K4
CO3	Interpret costing concepts with project execution.	K4
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques.	K2
CO5	Become familiar with quantitative techniques in cost management.	K3

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	1
CO2	2	1	1	1	-
CO3	2	2	2	-	-
CO4	1	1	1	1	1
CO5	1	2	1	1	-
23MFOE14	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1			40	60			100
CAT2		30	30	40			100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1			40	60			100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		30	30	40			100
ESE		20	40	40			100

23MFOE15	COMPOSITE MATERIALS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To summarize the characteristics of composite materials and effect of reinforcement in composite materials. • To identify the various reinforcements used in composite materials. • To compare the manufacturing process of metal matrix composites. • To understand the manufacturing processes of polymer matrix composites. • To analyze the strength of composite materials.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.		
UNIT – II	**REINFORCEMENT**	**9 Periods**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isosteresconditions.		
UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**	**9 Periods**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing- Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering–Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving- Properties and applications.		
UNIT – IV	**MANUFACTURING OF POLYMER MATRIX COMPOSITE**	**9 Periods**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.		
UNIT – V	**STRENGTH ANALYSIS OF COMPOSITES**	**9 Periods**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Chawla K.K.,* ***Composite Materials****, Springer, 2013.*
2	*Lubin.G,* ***Hand Book of Composite Materials****, Springer New York, 2013.*
3	*Deborah D.L. Chung,* ***Composite Materials Science and Applications****, Springer, 2011.*
4	*uLektz,* ***Composite Materials and Mechanics****, uLektz Learning Solutions Private Limited, Lektz, 2013.*
5	*https://nptel.ac.in/courses/112104168*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.	K2
CO2	Know the various reinforcements used in composite materials.	K2
CO3	Understand and apply the manufacturing processes of metal matrix composites	K3
CO4	Understand and apply the manufacturing processes of polymer matrix composites.	K3
CO5	Analyze the strength of composite materials.	K4

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	2	2	1	1	2
CO3	2	1	2	1	1
CO4	1	2	2	2	1
CO5	1	2	1	1	1
23MFOE15	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		60	40				100
CAT2			60	40			100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		60	40				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2			60	40			100
ESE		40	40	20			100

23TEOE16	GLOBAL WARMING SCIENCE (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To make the students learn about the material consequences of climate change, sea level change due to increase in the emission of greenhouse gases and to examine the science behind mitigation and adaptation proposals.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Terminology relating to atmospheric particles – Aerosols - Types, characteristics, measurements – Particle mass spectrometry - Anthropogenic-sources, effects on humans.						
UNIT – II	**CLIMATE MODELS**					**9 Periods**
General climate modeling- Atmospheric general circulation model - Oceanic general circulation model, sea ice model, land model concept, paleo-climate - Weather prediction by numerical process. Impacts of climate change - Climate Sensitivity - Forcing and feedback.						
UNIT – III	**EARTH CARBON CYCLE AND FORECAST**					**9 Periods**
Carbon cycle-process, importance, advantages - Carbon on earth - Global carbon reservoirs - Interactions between human activities and carbon cycle - Geologic time scales - Fossil fuels and energy - Perturbed carbon cycle.						
UNIT – IV	**GREENHOUSE GASES**					**9 Periods**
Blackbody radiation - Layer model - Earth's atmospheric composition and Green house gases effects on weather and climate - Radioactive equilibrium - Earth's energy balance.						
UNIT – V	**GEO ENGINEERING**					**9 Periods**
Solar mitigation - Strategies – Carbon dioxide removal - Solar radiation management - Recent observed trends in global warming for sea level rise, drought, glacier extent.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Eli Tziperman, **"Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences"**, Princeton University Press, 1st Edition, 2022.*
2	*John Houghton, **"Global warming: The Complete Briefing"**, Cambridge University Press, 5th Edition, 2015.*
3	*David Archer, **"Global warming: Understanding the Forecast"**, Wiley, 2nd Edition, 2011.*
4	*David S.K. Ting, Jacqueline A Stagner, **"Climate Change Science: Causes, Effects and Solutions for Global Warming"**, Elsevier, 1st Edition, 2021.*
5	*Frances Drake, **"Global Warming: The Science of Climate Change"**,Routledge, 1st edition, 2000.*
6	*Dickinson, **"Climate Engineering-A review of aerosol approaches to changing the global energybalance"**, Springer, 1996.*
7	*Andreas Schmittner, **"Introduction to Climate Science"**, Oregon State University, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the global warming in relation to climate changes throughout the earth.	K2
CO2	Assess the best predictions of current climate models.	K4
CO3	Understand the importance of carbon cycle and its implication on fossil fuels.	K2
CO4	Know about current issues, including impact from society, environment, economy as well as ecology related to greenhouse gases.	K4
CO5	Know the safety measures and precautions regarding global warming.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	1	1	2	1	1	1
CO3	1	2	1	1	1	2
CO4	1	1	1	1	1	2
CO5	2	1	2	1	1	2
23TEOE16	1	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

23TEOE17	INTRODUCTION TO NANO ELECTRONICS (Common to all Branches)

PREREQUISITES	CATEGORY	L	T	P	C
ENGINEERING PHYSICS	OE	3	0	0	3

Course Objectives	To make the students provide strong, essential, important methods and foundations of quantum mechanics and apply quantum mechanics on engineering fields.

UNIT – I	INTRODUCTION	9 Periods

Particles and Waves - Operators in quantum mechanics - The Postulates of quantum mechanics - The Schrodinger equation values and wave packet Solutions - Ehrenfest's Theorem.

UNIT – II	ELECTRONIC STRUCTURE AND MOTION	9 Periods

Atoms- The Hydrogen Atom - Many-Electron Atoms – Pseudopotentials, Nuclear Structure, Molecules, Crystals - Translational motion – Penetration through barriers – Particle in a box - Two terminal quantum dot devices - Two terminal quantum wire devices.

UNIT – III	SCATTERING THEORY	9 Periods

The formulation of scattering events - Scattering cross section - Stationary scattering state - Partial wave stationary scattering events - multi-channel scattering - Solution for Schrodinger equation- Radial and wave equation - Greens' function.

UNIT – IV	CLASSICAL STATISTICS	9 Periods

Probabilities and microscopic behaviours - Kinetic theory and transport processes in gases - Magnetic properties of materials - The partition function.

UNIT – V	QUANTUM STATISTICS	9 Periods

Statistical mechanics - Basic Concepts - Statistical models applied to metals and semiconductors - The thermal properties of solids- The electrical properties of materials - Black body radiation - Low temperatures and degenerate systems.

Contact Periods:

Lecture:45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications"****, Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis"****, Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*
5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the postulates of quantum mechanics.	K2
CO2	Know about nano electronic systems and building blocks.	K2
CO3	Solve the Schrodinger equation in 1D, 2D and 3Ddifferent applications.	K4
CO4	Learn the concepts involved in kinetic theory of gases.	K2
CO5	Know about statistical models applies to metals and semiconductor.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	2	2	1	1	1	1
CO3	2	2	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
23TEOE17	1	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	35	25	20	20	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	30	25	20	25	-	-	100
ESE	20	30	30	20	-	-	100

23TEOE18	GREEN SUPPLY CHAIN MANAGEMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To make the students learn and focus on the fundamental strategies, tools and techniques required to analyze and design environmentally sustainable supply chain systems.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Intro to SCM – complexity in SCM, Facility location - Logistics – Aim, activities, importance, progress, current trends - Integrating logistics with an organization.						
UNIT – II	**ESSENTIALS OF SUPPLY CHAIN MANAGEMENT**					**9 Periods**
Basic concepts of supply chain management - Supply chain operations – Planning and sourcing - Making and delivering - Supply chain coordination and use of technology - Developing supply chain systems.						
UNIT – III	**PLANNING THE SUPPLY CHAIN**					**9 Periods**
Types of decisions – strategic, tactical, operational - Logistics strategies, implementing the strategy - Planning resources – types, capacity, schedule, controlling material flow, measuring and improving performance.						
UNIT – IV	**ACTIVITIES IN THE SUPPLY CHAIN**					**9 Periods**
Procurement – cycle, types of purchase – Framework of e-procurement - Inventory management – EOQ, uncertain demand and safety stock, stock control - Material handling – Purpose of warehouse and ownership, layout, packaging - Transport – mode, ownership, vehicle routing and scheduling models- Travelling salesman problems - Exact and heuristic methods.						
UNIT – V	**SUPPLY CHAIN MANAGEMENT STRATEGIES**					**9 Periods**
Five key configuration components - Four criteria of good supply chain strategies - Next generation strategies- New roles for end-to-end supply chain management - Evolution of supply chain organization – International issues in SCM – Regional differences in logistics.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Hsiao-Fan Wang and Surendra M.Gupta,* ***"Green Supply Chain Management: Product Life Cycle Approach"****,McGraw-Hill Education, 1st Edition, 2011.*
3	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2017*
4	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*
5	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*
6	*S Emmett,* ***"Green Supply Chains: An Action Manifesto"****, John Wiley & Sons Inc, 2010.*
7	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Integrate logistics with an organization.	K2
CO2	Evaluate complex qualitative and quantitative data to support strategic and operational decisions.	K5
CO3	Develop self-leadership strategies to enhance personal and professional effectiveness.	K3
CO4	Analyze inventory management models and dynamics of supply chain.	K4
CO5	Identify issues in international supply chain management and outsources strategies.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	3
CO2	2	2	1	1	1	1
CO3	2	1	2	1	1	1
CO4	2	2	1	1	2	2
CO5	1	1	2	1	1	3
23TEOE18	2	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	10	10	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	30	20	25	15	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	35	30	25	10	-	-	100
ESE	30	30	20	10	10	-	100

23PSOE19	DISTRIBUTION AUTOMATION SYSTEM (Common to all Branches)	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To study about the distributed automation and economic evaluation schemes of power network

UNIT – I	INTRODUCTION	9 Periods

Introduction to Distribution Automation (DA) - Control system interfaces- Control and data requirements- Centralized (vs) decentralized control- DA system-DA hardware-DAS software.

UNIT – II	DISTRIBUTION AUTOMATION FUNCTIONS	9 Periods

DA capabilities - Automation system computer facilities- Management processes- Information management- System reliability management- System efficiency management- Voltage management- Load management.

UNIT – III	COMMUNICATION SYSTEMS	9 Periods

Communication requirements - reliability- Cost effectiveness- Data requirements- Two way capability- Communication during outages and faults - Ease of operation and maintenance- Conforming to the architecture of flow. Distribution line carrier- Ripple control-Zero crossing technique- Telephone, cableTV, radio, AM broadcast, FM SCA,VHF radio, microwave satellite, fiber optics-Hybrid communication systems used in field tests.

UNIT – IV	ECONOMIC EVALUATION METHODS	9 Periods

Development and evaluation of alternate plans- select study area – Select study period- Project load growth- Develop alternatives- Calculate operating and maintenance costs-Evaluate alternatives.

UNIT – V	ECONOMIC COMPARISON	9 Periods

Economic comparison of alternate plans-Classification of expenses - capital expenditures-Comparison of revenue requirements of alternative plans-Book life and continuing plant analysis- Year by year revenue requirement analysis, Short term analysis- End of study adjustment-Break even analysis, sensitivity analysis - Computational aids.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*M.K. Khedkar, G.M. Dhole, **"A Textbook of Electric Power Distribution Automation"**, Laxmi Publications, Ltd., 2010.*
2	*Maurizio Di Paolo Emilio, **"Data Acquisition Systems: From Fundamentals to Applied Design"**, Springer Science & Business Media, 21-Mar-2013*
3	*IEEE Tutorial course **"Distribution Automation"**, IEEE Working Group on Distribution Automation, IEEE Power Engineering Society. Power Engineering Education Committee, IEEE Power Engineering Society. Transmission and Distribution Committee, Institute of Electrical and Electronics Engineers, 1988*
4	*Taub, **"Principles Of Communication Systems",** Tata McGraw-Hill Education, 07-Sep-2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse the requirements of distributed automation	K1
CO2	Know the functions of distributed automation	K2
CO3	Perform detailed analysis of communication systems for distributed automation.	K3
CO4	Study the economic evaluation method	K4
CO5	Understand the comparison of alternate plans	K5

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	1
CO5	2	-	1	2
23PSOE19	3	-	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	10%	20%	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	10%	30%	20%	20%	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	10%	20%	20%	-	100%
ESE	30%	20%	20%	20%	10%	-	100%

23PSOE20	ELECTRICITY TRADING AND ELECTRICITY ACTS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To acquire expertise on Electric supply and demand of Indian Grid, gain exposure on energy trading in the Indian market and infer the electricity acts and regulatory authorities.					
UNIT – I	**ENERGY DEMAND**					**9 Periods**
Basic concepts in Economics - Descriptive Analysis of Energy Demand - Decomposition Analysis and Parametric Approach - Demand Side Management - Load Management - Demand Side Management - Energy Efficiency - Rebound Effect						
UNIT – II	**ENERGY SUPPLY**					**9 Periods**
Supply Behavior of a Producer - Energy Investment - Economics of Non-renewable Resources - Economics of Renewable Energy Supply Setting the context - Economics of Renewable Energy Supply - Economics of Electricity Supply						
UNIT – III	**ENERGY MARKET**					**9 Periods**
Perfect Competition as a Market Form - Why is the Energy Market not Perfectly Competitive? - Market Failure and Monopoly - Oil Market: Pre OPEC Era I - Oil Market: Pre OPEC Era II - Oil Market: OPEC						
UNIT – IV	**LAW ON ELECTRICITY**					**9 Periods**
Introduction of the Electricity Law; Constitutional Design - Evolution of Laws on Electricity Salient Features of Electricity Act, 2003 - Evolution of Laws on Electricity - Salient Features of the Electricity Act 2003						
UNIT – V	**REGULATORY COMMISSIONS FOR ELECTRICITY ACT**					**9 Periods**
Regulatory Commissions - Appellate Tribunal - Other Institutions under the Act - Electricity (Amendment) Bill 2020/2021. A Critical Comment - Renewable Energy - Role of Civil Society; Comments on Draft Renewable Energy Act, 2015						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance"****. Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*
4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe electric supply and demand of power grid	K1
CO2	Summarize various energy trading strategies	K2
CO3	Relate the electricity acts practically	K3
CO4	Cite the electricity regulatory authorities	K2
CO5	Analyze/check the existing power grid for its technical and economical sustainability	K4

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	1	1
CO3	3	-	2	2
CO4	3	-	1	2
CO5	3	-	3	3
23PSOE20	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	30%	30%	20%	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	-	20%	20%	-	100%

23PSOE21	MODERN AUTOMOTIVE SYSTEMS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To expose the students with theory and applications of Automotive Electrical and Electronic Systems.	
UNIT – I	**INTRODUCTION TO MODERN AUTOMOTIVE ELECTRONICS**	**9 Periods**
Introduction to modern automotive systems and need for electronics in automobiles- Role of electronics and microcontrollers- Sensors and actuators- Possibilities and challenges in automotive industry- Enabling technologies and industry trends.		
UNIT – II	**SENSORS AND ACTUATORS**	**9 Periods**
Introduction- basic sensor arrangement- Types of sensors- Oxygen sensor, engine crankshaft angular position sensor – Engine cooling water temperature sensor- Engine oil pressure sensor- Fuel metering- vehicle speed sensor and detonation sensor- Pressure Sensor- Linear and angle sensors- Flow sensor- Temperature and humidity sensors- Gas sensor- Speed and Acceleration sensors- Knock sensor- Torque sensor- Yaw rate sensor- Tyre Pressure sensor- Actuators - Stepper motors – Relays.		
UNIT – III	**POWERTRAIN CONTROL SYSTEMS IN AUTOMOBILE**	**9 Periods**
Electronic Transmission Control - Digital engine control system: Open loop and close loop control systems- Engine cooling and warm up control- Acceleration- Detonation and idle speed control - Exhaust emission control engineering- Onboard diagnostics- Future automotive powertrain systems.		
UNIT – IV	**SAFETY, COMFORT AND CONVENIENCE SYSTEMS**	**9 Periods**
Cruise Control- Anti-lock Braking Control- Traction and Stability control- Airbag control system- Suspension control- Steering control- HVAC Control.		
UNIT – V	**ELECTRONIC CONTROL UNITS (ECU)**	**9 Periods**
Introduction to Energy Sources for ECU, Need for ECUs- Advances in ECUs for automotives - Design complexities of ECUs- V-Model for Automotive ECU's- Architecture of an advanced microcontroller (XC166 Family, 32-bit Tricore) used in the design of automobile ECUs- On chip peripherals, protocol interfaces, analog and digital interfaces.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Enrique Acha, Manuel Madrigal**, "Power System Harmonics: Computer Modeling and Analysis**", John Wiley and Sons, 2001.*
2	*M. H. J. Bollen, **"Understanding Power Quality Problems, Voltage Sag and Interruptions",** IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H., **"Electrical Power SystemQuality"**, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt, **"Electric Power Quality",** Stars in a Circle Publications, 1994(2nd edition).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about conventional automotive control units and devices.	K1
CO2	Recognize the practical issues in the automotive control systems	K2
CO3	Analyze the impact of modern automotive techniques in various Engineering applications	K4
CO4	Develop modern automotive control system for electrical and electronics systems	K6
CO5	Understand the function of sensors and actuators	K2

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	2	-	3	1
CO5	2	-	1	2
23PSOE21	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	30%	-	20%	-	30%	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	20%	20%	-	-	100%

23PEOE22	VIRTUAL INSTRUMENTATION (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To comprehend the Virtual instrumentation programming concepts towards measurements and control and to instill knowledge on DAQ, signal conditioning and its associated software tools					
UNIT – I	**INTRODUCTION**					**7 Periods**
Introduction - advantages - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - Data-flow techniques, graphical programming in data flow, comparison with conventional programming.						
UNIT – II	**GRAPHICAL PROGRAMMING AND LabVIEW**					**9 Periods**
Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays – Clusters- Local and global variables – String - Timers and dialog controls.						
UNIT – III	**MANAGING FILES & DESIGN PATTERNS**					**11 Periods**
High-level and low-level file I/O functions available in LabVIEW – Implementing File I/O functions to read and write data to files – Binary Files – TDMS – sequential programming – State machine programming – Communication between parallel loops –Race conditions – Notifiers & Queues – Producer Consumer design patterns						
UNIT – IV	**PC BASED DATA ACQUISITION**					**9 Periods**
Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.						
UNIT – V	**DATA ACQUISITION AND SIGNAL CONDITIONING**					**9 Periods**
Components of a DAQ system, Bus, Signal and accuracy consideration when choosing DAQ hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple devices – Power quality analysis using Electrical Power Measurement tool kit.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Jeffrey Travis, Jim Kring, **"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),** Prentice Hall, 2006.*
2	*Jovitha Jerome, **"Virtual Instrumentation using LabVIEW",** PHI, 2010*
3	*Gary W. Johnson, Richard Jennings, **"LabVIEW Graphical Programming"**, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop, **"Learning with LabVIEW"**, Prentice Hall, 2013.*
5	*Kevin James, "**PC Interfacing and Data Acquisition: Techniques for Measurement**, **Instrumentation and Control"**, Newness, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the graphical programming techniques using LabVIEW software.	K2
CO2	Explore the basics of programming and interfacing using related hardware.	K4
CO3	Analyse the aspects and utilization of PC based data acquisition and Instrument interfaces.	K4
CO4	Create programs and Select proper instrument interface for a specific application.	K6
CO5	Familiarize and experiment with DAQ and Signal Conditioning	K3

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	3	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	10	10	20	30	20	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEOE23	ENERGY MANAGEMENT SYSTEMS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To Comprehend energy management schemes, perform energy audit and execute economic analysis and load management in electrical systems.					
UNIT – I	**GENERAL ASPECTS OF ENERGY AUDIT AND MANAGEMENT**					**9 Periods**
Energy Conservation Act 2001 and policies – Eight National Missions - Basics of Energy and its forms (Thermal and Electrical) - Energy Management and Audit - Energy Managers and Auditors - Types and Methodology Audit Report - Material and energy balance diagrams - .Energy Monitoring and Targeting.						
UNIT – II	**STUDY OF BOILERS, FURNACES AND COGENERATION**					**9 Periods**
Boiler Systems - Types - Performance Evaluation of boilers - Energy Conservation Opportunity - Steam Distribution - Efficient Steam Utilisation - Furnaces:types and classification - Performance evaluation of a typical fuel fired furnace. Cogeneration: Need - Principle - Technical options - classification - Technical parameters and factors influencing cogeneration choice - Prime Movers - Trigeneration.						
UNIT – III	**ENERGY STUDY OF ELECTRICAL SYSTEMS**					**9 Periods**
Electricity Billing – Electricity load management - Maximum Demand Control - Power Factor improvement and its benefits - pf controllers - capacitors - Energy efficient transformers and Induction motors - rewinding and other factors influencing energy efficiency - Standards and labeling programme of distribution transformers and IM - Analysis of distribution losses - demand side management - harmonics - filters - VFD and its selection.						
UNIT – IV	**STUDY OF ELECTRICAL UTILITIES**					**9 Periods**
Compressor types - Performance - Air system components - Efficient operation of compressed air systems- Compressor capacity assessment - HVAC: psychrometrics and air-conditioning processes - Types of refrigeration system - Compressor types and applications - Performance assessment of refrigeration plants - Lighting Systems: Energy efficient lighting controls - design of interior lighting - Case study.						
UNIT – V	**PERFORMANCE ASSESSMENT FOR EQUIPMENT**					**9 Periods**
Performing Financial analysis: Fixed and variable costs – Payback period – ROI - methods – factors affecting analysis. Energy Performance Assessment: Heat exchangers - Fans and Blowers - Pumps. Energy Conservation in buildings and ECBC.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Murphy W.R. and G.Mckay Butter worth , "**Energy Management**", Heinemann Publications, 2007*
2	*Albert Thumann, Terry Niehus, William J. Younger, "**Handbook of Energy Audits"**, Ninth Edition, River Publishers, 2012.*
3	*Dr. Subhash Gadhave Anup Goel Siddu S. Laxmikant D. Jathar, **"Energy Audit & Management"**, Second edition, Technical Publications, 2019.*
4	*S. M. Chaudhari, S. A. Asarkar, M. A. Chaudhari, **"Energy Conservation and Audit"**, Second Edition, Nirali Prakashan Publications, 2021.*
5	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the feature of energy audit methodology and documentation of report.	K3
CO2	Perform action plan and financial analysis	K4
CO3	Familiarize with thermal utilities.	K4
CO4	Familiarize with electrical utilities.	K4
CO5	Perform assessment of different systems.	K5

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	1	1
CO2	3	2	2	1	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
23PEOE23	3	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To explore the fundamentals, technologies and applications of energy storage	
UNIT – I	**ENERGY STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES**	**9 Periods**

Storage Needs- Variations in Energy Demand- Variations in Energy Supply- Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues-conventional energy storage methods: battery-types.

UNIT – II	**TECHNICAL METHODS OF STORAGE**	**9 Periods**

Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.

UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**	**9 Periods**

Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage.

UNIT – IV	**APPLICATION CONSIDERATION**	**9 Periods**

Comparing Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.

UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**	**9 Periods**

Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery + Capacitor" Combinations: need, operation and Merits; Level 2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES :

1	*DetlefStolten, "**Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**", Wiley, 2010.*
2	*Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "**Electrochemical Technologies for Energy Storage and Conversion**", John Wiley and Sons, 2012.*
3	*Francois Beguin and ElzbietaFrackowiak, "**Super capacitors**", Wiley, 2013.*
4	*Doughty Liaw, Narayan and Srinivasan, "**Batteries for Renewable Energy Storage**", The Electrochemical Society, New Jersy, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the historical perspective and technical methods of energy storage.	K1
CO2	Explain the basics of different storage methods.	K2
CO3	Determine the performance factors of energy storage systems.	K2
CO4	Identify applications for renewable energy systems.	K4
CO5	Outline the basics of Hydrogen cell and flow batteries.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
23PEOE24	3	1	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	10	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23AEOE25	DESIGN OF DIGITAL SYSTEMS (Common to all Branches)

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To gain knowledge in the design and VHDL programming of synchronous and asynchronous sequential circuits, PLD's and the basic concepts of testing in VLSI circuits	
UNIT–	**I SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Clocked Synchronous Sequential Circuits - Modeling, state table reduction, state assignment, Design of Synchronous Sequential circuits, Design of iterative circuits- ASM chart –ASM realization.		
UNIT–II	**ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Asynchronous Sequential Circuits - Races in ASC – Primitive Flow Table - Flow Table Reduction Techniques, State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards– Data Synchronizers.		
UNIT–III	**SYSTEM DESIGN USING PLDS**	**9 Periods**
Basic concepts – Programming Technologies - Programmable Logic Element (PLE) – Programmable Array Logic (PLA)-Programmable Array Logic (PAL) –Design of combinational and sequential circuits using PLDs– Complex PLDs (CPLDs).		
UNIT– IV	**INTRODUCTION TO VHDL**	**9 Periods**
Design flow -Software tools – VHDL: Data Objects-Data types – Operators –Entities and Architectures Components and Configurations – Signal Assignment – Concurrent and Sequential statements —Behavioral, Dataflow and Structural modeling– Transport and Inertial delays –Delta delays-Attributes - Generics–Packages and Libraries.		
UNIT–V	**LOGIC CIRCUIT TESTING AND TESTABLE DESIGN**	**9 Periods**
Digital logic circuit testing - Fault models - Combinational logic circuit testing - Sequential logic circuit testing- Design for Testability - Built-in Self-test, Board and System Level Boundary Scan - Case Study: Traffic Light Controller.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Donald G.Givone, "**Digital principles and Design**", TataMcGrawHill, 2002.*
2	*Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "**Digital Logic Circuit Analysis and Design**", Prentice Hall International, Inc., NewJersey, 1995.*
3	*VolneiA.Pedroni,"**Circuit Design withVHDL**", PHILearning,2011.*
4	*ParagK Lala,"**Digital Circuit Testing and Testability**", AcademicPress,1997.*
5	*CharlesHRoth,"**Digital Systems Design Using VHDL",** Cencage 2nd Edition2012.*
6	*NripendraN.Biswas,"**Logic Design Theory**" Prentice Hal l of India,2001.*

COURSEOUTCOMES: Upon completion of the course ,students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	To design synchronous sequential circuits based on specifications.	K3
CO2	To design asynchronous sequential circuits based on specifications	K3
CO3	Ability to illustrate digital design implementation using PLDs.	K2
CO4	To develop algorithm and VHDL code for design of digital circuits.	K3
CO5	Understand the different testing methods for combinational and sequential circuits.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE25	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	20%	45%	35%				100%

23AEOE26	BASICS OF NANO ELECTRONICS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	The students will be able to acquire knowledge about nano device fabrication technology, nano structures, nano technology for memory devices and applications of nano electronics in data transmission.	
UNIT – I	**TECHNOLOGY AND ANALYSIS**	**9 Periods**
Fundamentals : Dielectric, Ferroelectric and Optical properties - Film Deposition Methods – Lithography Material removing techniques - Etching and Chemical Mechanical Polishing - Scanning ProbeTechniques.		
UNIT – II	**CARBON NANO STRUCTURES**	**9 Periods**
Principles and concepts of Carbon Nano tubes - Fabrication - Electrical, Mechanical and VibrationProperties - Applications of Carbon Nano tubes.		
UNIT – III	**LOGIC DEVICES**	**9 Periods**
Silicon MOSFET's: Novel materials and alternative concepts - Single electron devices for logic applications - Super conductor digital electronics - Carbon Nano tubes for data processing.		
UNIT – IV	**MEMORY DEVICES AND MASS STORAGE DEVICES**	**9 Periods**
Flash memories - Capacitor based Random Access Memories - Magnetic Random Access Memories - Information storage based on phase change materials - Resistive Random Access Memories - HolographicData storage.		
UNIT – V	**DATA TRANSMISSION AND INTERFACING DISPLAYS**	**9 Periods**
Photonic Networks - RF and Microwave Communication System - Liquid Crystal Displays - Organic Light emitting diodes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Rainer Waser, "**Nano Electronics and Information Technology, Advanced Electronicmaterials and novel devices**", 3rd Edition, Wiley VCH, 2012.*
2	*T. Pradeep, "**Nano: The essentials**", Tata McGraw Hill, 2007.*
3	*Charles Poole, "**Introduction to Nano Technology**", Wiley Interscience, 2003*
4	*Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "**Introduction to Nano Electronics Science, Nanotechnology, Engineering and Applications**", Cambridge University Press, 2011.*
5	*C.Wasshuber Simon, "**Simulation of Nano Structures Computational Single-Electronics**",Springer, 2001.*
6	*Mark Reed and Takhee Lee, "**Molecular Nano Electronics, American Scientific Publisher,California**", 2003.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explain principles of nano device fabrication technology.	K2
CO2	Describe the concept of Nano tube and Nano structure.	K2
CO3	Explain the function and application of various nano devices	K3
CO4	Reproduce the concepts of advanced memory technologies.	K2
CO5	Emphasize the need for data transmission and display systems.	K2

COURSE ARTICULATION MATRIX									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	-	-	1	3	-	1
CO2	3	-	2	-	-	1	3	-	1
CO3	3	-	2	-	-	1	3	-	1
CO4	3	-	2	-	-	1	3	-	1
CO5	3	-	2	-	-	1	3	-	1
22AEOE26	3	-	2	-	-	1	3	-	1
1 – Slight, 2 – Moderate, 3 – Substantial									

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50%	25%	25%				100%
CAT2	50%	25%	25%				100%
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	50%	25%	25%				100%
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2	50%	25%	25%				100%
ESE	50%	25%	25%				100%

23AEOE27	ADVANCED PROCESSOR (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	The students will be able to acquire knowledge about the high performance RISC, CISC and special purpose processors.	
UNIT – I	**MICROPROCESSOR ARCHITECTURE**	**9 Periods**
Instruction set – Data formats – Instruction formats – Addressing modes – Memory hierarchy – registerfile – Cache – Virtual memory and paging – Segmentation – Pipelining – The instruction pipeline – pipeline hazards – Instruction level parallelism – reduced instruction set – Computer principles – RISCversus CISC – RISC properties – RISC evaluation.		
UNIT – II	**HIGH PERFORMANCE CISC ARCHITECTURE –PENTIUM**	**9 Periods**
The software model – functional description – CPU pin descriptions – Addressing modes – Processor flags – Instruction set – Bus operations – Super scalar architecture – Pipe lining – Branch prediction – The instruction and caches – Floating point unit– Programming the Pentium processor.		
UNIT – III	**HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM INTERFACE**	**9 Periods**
Protected mode operation – Segmentation – paging – Protection – multitasking – Exception and interrupts- Input /Output – Virtual 8086 model – Interrupt processing.		
UNIT – IV	**HIGH PERFORMANCE RISC ARCHITECTURE: ARM**	**9 Periods**
ARM architecture – ARM assembly language program – ARM organization and implementation – ARM instruction set - Thumb instruction set.		
UNIT – V	**SPECIAL PURPOSE PROCESSORS**	**9 Periods**
Altera Cyclone Processor – Audio codec – Video codec design – Platforms – General purpose processor –Digital signal processor – Embedded processor – Media Processor – Video signal Processor – Custom Hardware – Co-Processor.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Daniel Tabak, "**Advanced Microprocessors**", McGraw Hill Inc., 2011.*
2	*James L. Antonakos, "**The Pentium Microprocessor**", Pearson Education, 1997.*
3	*Steve Furber, "**ARM System –On –Chip architecture**", Addison Wesley, 2009.*
4	*Gene. H. Miller, "**Micro Computer Engineering**", Pearson Education, 2003.*
5	*Barry. B. Brey, "**The Intel Microprocessors Architecture, Programming and Interfacing**", PHI, 2008.*
6	*Valvano, "**Embedded Microcomputer Systems**" Cencage Learing India Pvt Ltd, 2011.*
7	*Iain E.G. Richardson, "**Video codec design**", John Wiley & sons Ltd, U.K, 2002.*

COURSE OUTCOMES: Upon completion of the course, students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamentals of various processor architecture.	K2
CO2	Interpret and understand the high performance features in CISC architecture.	K2
CO3	Describe the concepts of Exception and interrupt processing.	K2
CO4	Develop programming skill for ARM processor.	K3
CO5	Explain various special purpose processor	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
22AEOE27	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	30%	40%	30%				100%

23VLOE28	HDL PROGRAMMING LANGUAGES (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	OE	**3**	**0**	**0**	**3**

Course Objective	To code and simulate any digital function in Verilog HDL and understand the difference between synthesizable and non-synthesizable codes.	
UNIT – I	**VERILOG INTRODUCTION AND MODELING**	**9 Periods**
Introduction to Verilog HDL, Language Constructs and Conventions, Gate Level Modeling, Modeling at Dataflow Level, Behavioral Modeling, Switch Level Modeling, System Tasks, Functions and Compiler Directives.		
UNIT – II	**SEQUENTIAL MODELING AND TESTING**	**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Test Bench - Combinational Circuits Testing, Sequential Circuit Testing, Test Bench Techniques, Design Verification, Assertion Verification.		
UNIT – III	**SYSTEM VERILOG**	**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions, system verilog Procedural Blocks, Tasks and Functions.		
UNIT – IV	**SYSTEM VERILOG MODELING**	**9 Periods**
System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog, System Verilog Design Hierarchy.		
UNIT – V	**INTERFACES AND DESIGN MODEL**	**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**		

REFERENCES:

1	*T.R.Padmanabhan, B Bala Tripura Sundari, "**Design through Verilog HDL"**,Wiley 2009.*
2	*Stuart Sutherland, Simon Davidmann ,Peter Flake , Foreword by Phil Moorby, "**System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling"**, Springer 2006.*
3	*Samir Palnitkar, "**Verilog HDL**", 2nd Edition, Pearson Education, 2009.*
4	*ZainalabdienNavabi,"**Verilog Digital System Design"**,TMH,2ndEdition,2005.*
5	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
6	*Dr.SRamachandran, "**Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog"**, Springer, 2007.*
7	*Chris Spear, "**System verilog for verification a guide to learning the test bench Language Features**", Springer 2006.*
6	*Stuart Sutherland, Simon Davidmann, Peter Flake, "**System Verilog For Design: A Guide to Using System Verilog for Hardware Design and Modeling**" 1st Edition, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop sequential modeling based Verilog HDL code and develop the test bench for the modeling	K3
CO3	Explain the system verilog modeling	K2
CO4	Differentiate the synthesizable and non-synthesizable code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		2		2
CO2	3	3		2		2
CO3	3	3		2		2
CO4	3	3		2		2
CO5	3	3		2		2
23VLOE28	3	3		2		2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE29	CMOS VLSI DESIGN (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	To gain knowledge on CMOS Circuits with its characterization and to design CMOS logic and sub-system with low power					
UNIT – I	**INTRODUCTION TO MOS CIRCUITS**					**9 Periods**
MOS Transistor Theory -Introduction MOS Device Design Equations -MOS Transistor as a Switches - Pass Transistor - CMOS Transmission Gate -Complementary CMOS Inverter - Static Load MOS Inverters - Inverters with NMOS loads - Differential Inverter - Tri State Inverter - BiCMOS Inverter.						
UNIT – II	**CIRCUIT CHARACTERIZATION AND PERFORMANCE ESTIMATION**					**9 Periods**
Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Sizing Routing Conductors, Charge Sharing, Design Margin and Reliability.						
UNIT – III	**CMOS CIRCUIT AND LOGIC DESIGN**					**9 Periods**
CMOS Logic Gate Design, Physical Design of CMOS Gate, Designing with Transmission Gates, CMOS Logic Structures, Clocking Strategies, I/O Structures.						
UNIT – IV	**CMOS SUBSYSTEM DESIGN**					**9 Periods**
DataPath Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multipliers, Shifters, Memory Elements, Control-FSM, Control Logic Implementation.						
UNIT – V	**LOWPOWERCMOS VLSIDESIGN**					**9 Periods**
Introduction to Low Power Design, Power Dissipation in FET Devices, Power Dissipation in CMOS, Low-Power Design through Voltage Scaling – VTCMOS Circuits, MTCMOS Circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Low Power Basics CMOS Gate and Adder Design.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Sung Mo Kang,Yusuf Lablebici,**"CMOS Digital Integrated Circuits:Analysis & Design"**, Tata Mc-Graw Hill, 2011.*
2	*N.Weste and K.Eshranghian, **"Principles of CMOS VLSI Design"**, AddisonWesley,1998.*
3	*Neil H. E. Weste, David Harris, Ayan Banerjee, **"CMOS VLSI Design: A Circuits and Systems Perspective"**, Pearson Education 2013.*
4	*Kiat-Seng Yeo,Kaushik Roy,**"Low-Voltage, Low-Power VLSI Subsystems",** McGraw-Hill Professional, 2004.*
5	*Gary K.Yeap, **"Practical Low Power Digital VLSI Design"**, Kluwer Academic Press, 2002.*
6	*Jan M .Rabaey,**"Digital Integrated Circuits: A Design Perspective"**, Pearson Education, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the MOS circuits and Transmission gates	K2
CO2	Illustrate the CMOS Circuits with its characterization	K2
CO3	Design CMOS logic circuits	K3
CO4	Design CMOS sub-system	K3
CO5	Discuss low power CMOS VLSI Design	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	2	-	3
CO2	2	1	-	2	-	3
CO3	2	1	-	2	-	3
CO4	3	1	-	2	-	3
CO5	3	1	-	2	-	3
23VLOE29	**3**	**1**	**-**	**2**	**-**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE30	HIGH LEVEL SYNTHESIS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	To provide students with foundations in High level synthesis, verification and CAD Tools					
UNIT – I	**HIGH-LEVEL SYNTHESIS (HLS) FUNDAMENTALS**					**9 Periods**
Overview HLS flow, Scheduling Techniques, Resource sharing and Binding Techniques, Data-path and Controller Generation Techniques.						
UNIT – II	**HIGH LEVEL SYNTHESIS**					**9 Periods**
Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.						
UNIT – III	**HIGH-LEVEL SYNTHESIS VERIFICATION**					**9 Periods**
Simulation based verification - Formal Verification of digital systems- BDD based approaches, functional equivalence, finite state automata, ω-automata, FSM verification.						
UNIT – IV	**CAD TOOLS FOR SYNTHESIS**					**9 Periods**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.						
UNIT – V	**ADVANCED TOPICS**					**9 Periods**
Relative Scheduling, IO scheduling modes - cycle fixed scheduling modes, super-fixed scheduling modes, free-floating scheduling mode, Pipelining, Handshaking, System Design, High-Level Synthesis for FPGA.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Philippe Coussy and Adam Morawiec, "**High-level Synthesis from Algorithm to Digital Circuit**", Springer, 2008.*
2	*Sherwani, N., "**Algorithms for VLSI Physicsl Design Automation**", Springer, 3rd ed., 2005.*
3	*D. Micheli,"**Synthesis and optimization of digital systems**", Mc Graw Hill, 2005.*
4	*Dutt, N. D. and Gajski, D. D., "**High level synthesis**", Kluwer, 2000.*
5	*Gerez S.H., "**Algorithms for VLSI Design Automation**", John Wiley (1998)*
6	*David. C. Ku and G. De Micheli, "**High-level Syntehsis of ASICs Under Timing and Synchronization Constraints**", Kluwer Academic Publishers, 1992.*
7	*K. Parhi, "**VLSI Digital Signal Processing Systems: Design and Implementation**", Jan 1999, Wiley.*
8	*Egon Boerger and Robert Staerk "**Abstract State Machines: A Method for High-Level System Design and Analysis**", Springer,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of High level synthesis	K2
CO2	Synthesis the HDL for operation scheduling	K2
CO3	Simulate and verify any digital systems	K2
CO4	Apply CAD tools for synthesis	K2
CO5	Have knowledge on various scheduling modes	K2

COURSE ARTICULATION MATRIX:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	2	2	-
CO2	2	2	-	2	2	-
CO3	2	2	-	2	2	-
CO4	2	2	-	2	2	-
CO5	2	2	-	2	2	-
23VLOE30	**2**	**2**	**-**	**2**	**2**	**-**

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50%	50%		-	-	-	100%
CAT2	50%	50%		-	-	-	100%
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50%	50%	-	-	-	100%
ESE	50%	50%		-	-	-	100%

23CSOE31	ARTIFICIAL INTELLIGENCE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**9 Periods**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**9 Periods**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**9 Periods**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**9 Periods**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**9 Periods**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Deepak Khemani, **"A First Course in Artificial Intelligence",** Tata Mc Graw Hill Education 2013*
2	*Yang Q, **" Intelligent Planning: A decomposition and Abstraction based Approach",** Springer, 2006*
3	*Russell and Norvig, **"Artificial Intelligence, A Modern Approach**", 3rd edition, Pearson Prentice Hall,2010.*
4	*Elaine Rich,Kevin Knight,Shivashankar B. Nair, **"Artificial Intelligence",** 3rd edition, TataMcGraw Hill, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use search techniques to solve AI problems	K2
CO2	Reason facts by constructing plans and understand uncertainty efficiently.	K3
CO3	Examine data using statistical codes and solve complex AI problems	K6
CO4	Apply techniques to make apt decisions.	K4
CO5	Use deep reinforcement learning to solve complex AI problems	K6

COURSE ARTICULATION MATRIX						
COs/ POs	**PO 1**	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO6**
CO1	3		2		3	3
CO2	3		2		3	3
CO3	3		3		3	3
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE31	3		3		3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		20	40	20	20		100
CAT2		10	20	40	10	20	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1					50	50	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2					50	50	100
ESE	30	30	40				100

23CSOE32	COMPUTER NETWORK MANAGEMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	After the completion of the course, the students will be able to understand the concept of layering in networks, functions of protocols of each layer of TCP/IP protocol suite, concepts related to network addressing and routing and build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes using Cisco Packet Tracer.

UNIT – I	**INTRODUCTION AND APPLICATION LAYER**	**9 Periods**

Building network – Network Edge and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics - Ethernet Networking – Introduction to Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.

UNIT – II	**TRANSPORT LAYER AND ROUTING**	**9 Periods**

Transport Layer functions –User Datagram Protocol – Transmission Control Protocol – Flow Control – Retransmission Strategies – Congestion Control - Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – BGP – Introduction to Quality of Service (QoS).Case Study: Configuring RIP, OSPF BGP using Packet tracer

UNIT – III	**NETWORK LAYER**	**9 Periods**

Network Layer: Switching concepts – Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – Variable Length Subnet Mask (VLSM) – DHCP – ARP – Network Address Translation (NAT) – ICMP – Concept of SDN.Case Study: Configuring VLAN, DHCP, NAT using Packet tracer

UNIT – IV	**INTERNETWORK MANAGEMENT**	**9 Periods**

Introduction to the Cisco IOS - Router User Interface – CLI - Router and Switch Administrative Functions - Router Interfaces - Viewing, Saving, and Erasing Configurations - Switching Services - Configuring Switches - Managing Configuration Registers - Backing Up and Restoring IOS - Backing Up and Restoring the Configuration - Using Discovery Protocol (CDP) - Checking Network Connectivity

UNIT – V	**TRAFFIC MANAGEMENT AND WAN PROTOCOLS**	**9 Periods**

Managing Traffic with Access Lists: Introduction to Access Lists - Standard Access Lists - Extended Access Lists - Named Access Lists - Monitoring Access Lists - Wide Area Networking Protocols: Introduction to Wide Area Networks - Cabling the Wide Area Network - High-Level Data-Link Control (HDLC) Protocol - Point-to-Point Protocol (PPP) - Frame Relay: Frame Relay Implementation and Monitoring - Integrated Services Digital Network (ISDN) - Dial-on-Demand Routing (DDR): Configuring DDR

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES :

1	*James F. Kurose, Keith W. Ross,* ***"Computer Networking: A Top-Down Approach",*** *Seventh Edition, Pearson Education, 2017.*
2	*William Stallings,* ***"Data and Computer Communications",*** *Tenth Edition, Pearson Education, 2014*
3	*Larry L. Peterson, Bruce S. Davie,* ***"Computer Networks: A Systems Approach",*** *Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
4	*Todd Lammle,* ***"CCNA™: Cisco® Certified Network Associate Study Guide",*** *5th Edition, Sybex, 2003*
5	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker,* ***"Computer Networks: An Open Source Approach",*** *McGraw Hill, 2012.*
6	*Ron Gilster, Jeff Bienvenu, and Kevin Ulstad,* ***"CCNA for Dummies",*** *IDG Books Worldwide, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Highlight the significance of the functions of each layer in the network.	K1
CO2	Identify the devices and protocols to design a network and implement it.	K4
CO3	Apply addressing principles such as subnetting and VLSM for efficient routing.	K3
CO4	Build simple LANs, perform basic configurations for routers and switches	K6
CO5	Illustrate various WAN protocols	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		3		2	1
CO2	3		3		2	2
CO3	3		3		3	2
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE32	3		3		3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20			100
CAT2		30	20	30	10	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	10	30	20	20	20		100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2		20	20	20	20	20	100
ESE	20	40	40				100

23CSOE33	BLOCKCHAIN TECHNOLOGIES (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	The objective of the course is to explore basics of block chain technology and its application in various domaiin	
UNIT – I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**	**9 Periods**
History of Blockchain - Types of blockchain- CAP theorem and blockchain – benefits and Limitations of Blockchain – Decentalization using blockchain – Blockchain implementations- Block chain in practical use - Legal and Governance Use Cases		
UNIT – II	**BITCOIN AND CRYPTOCURRENCY**	**9 Periods**
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency		
UNIT – III	**ETHEREUM**	**9 Periods**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts		
UNIT – IV	**HYPERLEDGER AND SOLIDITY PROGRAMMING**	**9 Periods**
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity – Programming with solidity		
UNIT – V	**BLOCKCHAIN APPLICATIONS**	**9 Periods**
Ten Steps to build your Blockchain application – Application: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Imran Bashir, **"Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained"**, Second Edition, Packt Publishing, 2018.*
2	*Joseph J. Bambara Paul R. Allen, **"Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions"**,McGraw Hill Education ,2018.*
3	*Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, **"Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"** Princeton University Press, 2016.*
4	*Manav Gupta **"Blockchain for Dummies",** IBM Limited Edition 2017.*
5	*Antonopoulos and G. Wood, **"Mastering Ethereum: Building Smart Contracts and Dapps",** O'Reilly Publishing, 2018*
6	***NPTEL Course : Blockchain and its applications** https://archive.nptel.ac.in/courses/106/105/106105235/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the working of Blockchain technology	K2
CO2	Narrate working principle of smart contracts and create them using solidity for given scenario.	K3
CO3	Comprehend the working of Hyperledger in an real time application	K2
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	K3
CO5	Develop applications on Blockchain	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3	2		3
CO2	2	3	3	3	2	3
CO3	3		3	2		3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
23CSOE33	**3**	**3**	**3**	**3**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	30	50				100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1		30	70				100
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2		40	60				100
ESE	10	60	30				100

23EEACZ1	ENGLISH FOR RESEARCH PAPER WRITING (Common to all Branches)

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	The objective of the course is to make the learners understand the format and intricacies involved in writing a research paper.	
UNIT – I	**PLANNING AND PREPARATION**	**6 Periods**
Need for publishing articles, Choosing the journal, Identifying a model journal paper, Creation of files for each section, Expectations of Referees, Online Resources.		
UNIT – II	**SENTENCES AND PARAGRAPHS**	**6 Periods**
Basic word in English, Word order in English and Vernacular, placing nouns, Verbs, Adjectives, and Adverb suitably in a sentence, Using Short Sentences, Discourse Markers and Punctuations- Structure of a Paragraph, Breaking up lengthy Paragraphs.		
UNIT – III	**ACCURACY, BREVITY AND CLARITY (ABC) OF WRITING**	**6 Periods**
Accuracy, Brevity and Clarity in Writing, Reducing the linking words, Avoiding redundancy, Appropriate use of Relative and Reflexive Pronouns, Monologophobia, verifying the journal style, Logical Connections between others author's findings and yours.		
UNIT – IV	**HIGHLIGHTING FINDINGS, HEDGING AND PARAPHRASING**	**6 Periods**
Making your findings stand out, Using bullet points headings, Tables and Graphs- Availing non-experts opinions, Hedging, Toning Down Verbs, Adjectives, Not over hedging, Limitations of your research.		
UNIT – V	**SECTIONS OF A PAPER**	**6 Periods**
Titles, Abstracts, Introduction, Review of Literature, Methods, Results, Discussion, Conclusions, References.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Goldbort R* ***, "Writing for Science", Yale University Press*** *(available on GoogleBooks),2006*
2	*Day R ,* ***How to Write and Publish a Scientific Paper****, Cambridge University Press, 2006.*
3	*Highman N,* ***"Handbook of Writing for the Mathematical Sciences"****, SIAM. Highman's book, 1998.*
4	*Adrian Wallwork,"* ***English for Writing Research Papers"****, Springer New York Dordrecht Heidelberg London, 2011.*

COURSE OUTCOMES : Upon completion of this course the learners will be able to		Bloom's Taxonomy Mapped
CO1	**U**nderstand the need for writing good research paper.	K2
CO2	Practice the appropriate word order, sentence structure and paragraph writing.	K4
CO3	Practice unambiguous writing.	K3
CO4	Avoid wordiness in writing.	K2
CO5	Exercise the elements involved in writing journal paper.	K3

COURSE ARTICULATION MATRIX :						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23EEACZ1	3	3	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	-	50	50	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50	50	-	-	-	100
ESE	30	30	40	-	-	-	100

23EEACZ2	DISASTER MANAGEMENT (Common to all Branches)	
Course Objectives	• To become familiar in key concepts and consequences about hazards, disaster and area of occurrence. • To know the various steps in disaster planning. • To create awareness on disaster preparedness and management.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Areas proneto ,sekauqhtraEFloods ,Droughts, Landslides , Avalanches ,Cyclone and Coastal Hazards with Special Reference to Tsunami.		
UNIT – II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6 Periods**
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.		
UNIT – III	**DISASTER PLANNING**	**6 Periods**
Disaster Planning-Disaster Response Personnel roles and duties, Community MitigationGoals, Pre-Disaster Mitigation Plan, Personnel Training, Comprehensive Emergency Management, Early Warning Systems.		
UNIT – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6 Periods**
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.		
UNIT – V	**RISK ASSESSMENT**	**6 Periods**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0Periods Total: 30 Periods**		

REFERENCES:

1	*R. Nishith, Singh AK, **"Disaster Management In India: Perspectives, Issues And Strategies"**, New Royal book Company, 2007.*
2	*Sahni, PardeepEt.Al. (Eds.), **"Disaster Mitigation Experiences And Reflections"**, Prentice Hall Of India, New Delhi, 2010*
3	*Goel S. L, **"Disaster Administration And Management Text And Case Studies"**, Deep & Deep Publication Pvt. Ltd., New Delhi, 2008.*
4	*Jagbir Singh, **"Disaster Management: Future Challenges And Opportunities"**, I.K. International Publishing House Pvt. Ltd., New Delhi, 2007.*
5	*Damon Coppola **"Introduction To International Disaster Management"**, Butterworth-Heinemann, 2015*
6	*Ryan Lanclos **"Dealing With Disasters: Gis For Emergency Management"**,ESRI Press 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate hazard and disaster with their significance.	K4
CO2	Analyse the causes and impact of natural and manmade disaster.	K4
CO3	Execute the steps involved in disaster planning.	K4
CO4	Predict vulnerability of disaster and to prevent, mitigate their impact.	K4
CO5	Prepare risk assessment strategy for national and global disaster.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23EEACZ2	1	1	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2			100				100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	50	50					100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2			100				100
ESE	25	25	50				100

23EEACZ3	VALUE EDUCATION (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• Value of education and self- development • Requirements of good values in students • Importance of character	
UNIT – I	**ETHICS AND SELF-DEVELOPMENT**	**6 Periods**
Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements.		
UNIT – II	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	**6 Periods**
Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.		
UNIT – III	**VALUES IN HUMAN LIFE**	**6 Periods**
Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.		
UNIT – IV	**VALUES IN SOCIETY**	**6 Periods**
True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association andCooperation. Doing best for saving nature.		
UNIT – V	**POSITIVE VALUES**	**6 Periods**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.		
Contact Periods: **Lecture: 30 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**		

REFERENCES :

1	*Chakroborty, S.K.* ***"Values and Ethics for organizations Theory and practice"****, Oxford University Press, New Delhi,1998*
2	*Dr. Yogesh Kumar Singh,* ***"Value Education"****, A.P.H Publishing Corporation, New Delhi,2010*
3	*R.P Shukla,* ***"Value Education and Human Rights"****, Sarup and Sons, NewDelhi,2004*
4	*https://nptel.ac.in/courses/109104068/36*

COURSE OUTCOMES : Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the values and work ethics.	K3
CO2	Enhance personality and 152ehavior development.	K3
CO3	Apply the values in human life.	K3
CO4	Gain Knowledge of values in society.	K3
CO5	Learn the importance of positive values in human life.	K3

COURSE ARTICULATION MATRIX						
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	-	-	3	-	-	1
CO4	-	-	3	-	-	1
CO5	-	-	3	-	-	1
23EEACZ3	-	-	3	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EEACZ4	CONSTITUTION OF INDIA (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To address the importance of constitutional rights and duties • To familiarize about Indian governance and local administration. • To know about the functions of election commission.	
UNIT – I	**INDIAN CONSTITUTION**	**6 Periods**
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features.		
UNIT – II	**CONSTITUTIONAL RIGHTS & DUTIES**	**6 Periods**
Contours of Constitutional Rights & Duties: Fundamental Rights , Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
UNIT – III	**ORGANS OF GOVERNANCE**	**6 Periods**
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
UNIT – IV	**LOCAL ADMINISTRATION**	**6 Periods**
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass		
UNIT – V	**ELECTION COMMISSION**	**6 Periods**
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	***"The Constitution of India"**, 1950 (Bare Act), Government Publication.*
2	*Dr. S. N. Busi, Dr. B. R. Ambedkar **"Framing of Indian Constitution"**, 1st Edition, 2015.*
3	*M. P. Jain,"**Indian Constitution Law"**, 7th Edn., Lexis Nexis, 2014.*
4	*D.D. Basu,"**Introduction to the Constitution of India"**, Lexis Nexis, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India.	K2
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	K2
CO3	Understand the various organs of Indian governance.	K2
CO4	Familiarize with the various levels of local administration.	K2
CO5	Gain knowledge on election commission of india.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	1	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	1	1
CO5	-	-	1	1	1	1
23EEACZ4	**-**	**-**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EEACZ5	PEDAGOGY STUDIES (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. • Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.		
UNIT – II	**PEDAGOGICAL PRACTICES**	**6 Periods**
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies.		
UNIT – III	**PEDAGOGICAL APPROACHES**	**6 Periods**
How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teacher's attitudes and beliefs and Pedagogic strategies.		
UNIT – IV	**PROFESSIONAL DEVELOPMENT**	**6 Periods**
Professional development: alignment with classroom practices and follow-up support. Peer support , Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.		
UNIT – V	**CURRICULUM AND ASSESSMENT**	**6 Periods**
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.		

Contact Periods:

Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES:

1	*Ackers J, Hardman F , **Classroom interaction in Kenyan primary schools,Compare**, 31 (2): 245-261, 2001.*
2	*Alexander RJ , **Culture and pedagogy: International comparisons in primary education**. Oxford and Boston: Blackwell, 2001*
3	*Akyeampong K, Lussier K, Pryor J, Westbrook J, **Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?** International Journal Educational Development, 33 (3): 272–282, 2013.*
4	*Agrawal M ,**Curricular reform in schools: The importance of evaluation**, Journal of Curriculum Studies, 36 (3): 361-379, 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of curriculum, formal and informal education systems and teacher education.	K3
CO2	Explain the present pedagogical practices and the changes occurring in pedagogical approaches	K3
CO3	Understand the relation between teacher and community, support from various levels of teachers to students and limitation in resources and size of the class.	K3
CO4	Perform research in design a problem in pedagogy and curriculum development.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23EEACZ5	**-**	-	**1**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EEACZ6	STRESS MANAGEMENT BY YOGA (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	AC	2	0	0	0

Course Objectives	• To create awareness on the benefits of yoga and meditation. • To understand the significance of Asana and Pranayama.

UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**	**6 Periods**

Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.

UNIT – II	**YOGA TERMINOLOGIES**	**6 Periods**

Yamas - Ahimsa, satya, astheya, bramhacharya, aparigraha
Niyamas- Saucha, santosha, tapas, svadhyaya, Ishvara pranidhana.

UNIT – III	**ASANA**	**6 Periods**

Asana - Rules & Regulations – Types & Benefits

UNIT – IV	**PRANAYAMA**	**6 Periods**

Regularization of breathing techniques and its effects-Types of pranayama

UNIT – V	**MIND**	**6 Periods**

Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity.

Contact Periods:
Lecture: 30 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**

REFERENCES :

1	*Janardan Swami Yogabhyasi Mandal , **"Yogic Asanas for Group Training-Part-I"**, Nagpur.*
2	*Swami Vivekananda, **"Rajayoga or conquering the Internal Nature"**, Advaita Ashrama (Publication Department), Kolkata.*
3	*Pandit Shambu Nath, **"Speaking of Stress Management Through Yoga and Meditation"**, New Dawn Press, New Delhi, 2016.*
4	*K. N. Udupa, **"Stress and its management by Yoga",** Motilal Banarsidass Publishers, New Delhi, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Practice physical exercises and maintain good health.	K3
CO2	Attain knowledge on the various concepts of Yoga.	K2
CO3	Perform various asanas with an understanding on their benefits.	K3
CO4	Practice breathing techniques in a precise manner.	K3
CO5	Attain emotional stability and higher level of consciousness.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	-	-	-	2
CO2	-	-	-	-	3
CO3	-	-	-	-	2
CO4	-	-	-	-	1
CO5	-	-	-	-	1
23EEACZ6	-	-	-	-	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	30%	30%	-	-	-	100%
CAT2	30%	40%	30%	-	-	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	40%	40%	20%	-	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	30%	30%	40%	-	-	-	100%
ESE	30%	30%	40%	-	-	-	100%

23EEACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Common to all Branches)				
PREREQUISITES :	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	AC	**2**	**0**	**0**	**0**

Course Objectives	• To familiar with Techniques to achieve the highest goal in life. • To become a person with stable mind, pleasing personality and determination.

UNIT – I	**6 Periods**
Neetisatakam-Holistic development of personality-Verses- 19,20,21,22 (wisdom)-Verses29,31,32 (pride & heroism)-Verses- 26,28,6.	
UNIT – II	**6 Periods**
Verses- 52,53,59 (dont's)-Verses- 71,73,75,78 (do's). - Approach to day to day work and duties.- Shrimad BhagwadGeeta - Chapter 2-Verses 41, 47,48,	
UNIT – III	**6 Periods**
Shrimad BhagwadGeeta -Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,- Chapter 18-Verses 45, 46, 48.	
UNIT – IV	**6 Periods**
Statements of basic knowledge.-Shrimad BhagwadGeeta: -Chapter2-Verses 56, 62, 68 -Chapter 12 -Verses 13, 14, 15, 16,17, 18-Personality of Role model.	
UNIT – V	**6 Periods**
Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63.	

Contact Periods:
Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES :

1	*Swami SwarupanandaAdvaita Ashram "**Srimad Bhagavad Gita**",AdvaitaAshrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, JagadguruKripalujiYog "**Bhagavad Gita: The Song Of God**", USA,2019*
4	*A.C. Bhaktivedanta Swami Prabhupada "**Bhagavad-Gita As It Is**",Bhaktivedanta Book Trust Publications,2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Holistic development in life	K4
CO2	Effective Planning of day to day work and duties	K4
CO3	Identify mankind to peace and prosperity	K4
CO4	Develop versatile personality.	K4
CO5	Awakening wisdom in life	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	-	-	-
CO2	-	-	1	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	1	-	-	-
CO5	-	-	1	-	-	-
23EEACZ7	**-**	**-**	**1**	**-**	**-**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23EEACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE (Common to all Branches)				
PREREQUISITES:	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To get a working knowledge in illustrious Sanskrit, the scientific language in the world. • Learning of Sanskrit to improve brain functioning. • Enhancing the memory power. • Learning of Sanskrit to develop the logic in mathematics, science & other subjects.	
UNIT – I	**BASICS OF SANSKRIT**	**6 Periods**
Alphabets in Sanskrit, Past/Present/Future Tense.		
UNIT – II	**SENTENCES AND ROOTS**	**6 Periods**
Simple Sentences - Order, Introduction of roots		
UNIT – III	**SANSKRIT LITERATURE**	**6 Periods**
Technical information about Sanskrit Literature		
UNIT – IV	**TECHNICAL CONCEPTS -1**	**6 Periods**
Technical concepts of Engineering-Electrical, Mechanical		
UNIT – V	**TECHNICAL CONCEPTS -2**	**6 Periods**
Technical concepts of Engineering-Architecture, Mathematics		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*Dr.Vishwas, "**Abhyaspustakam",** Samskrita -Bharti Publication, New Delhi, 2020.*
2	*Prathama Deeksha Vempati Kutumbshastri, "**Teach Yourself Sanskrit**", Rashtriya Sanskrit Sansthanam, New Delhi, Publication, 2009.*
3	*Suresh Soni, **"India's Glorious Scientific Tradition**" , Ocean books (P) Ltd., New Delhi,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize ancient literature and their basics	K3
CO2	Formulate the sentences with order and understand the roots of Sanskrit	K2
CO3	Acquire familiarity of the major traditions of literatures written in Sanskrit	K3
CO4	Distinguish the Technical concepts of Electrical & Mechanical Engineering	K2
CO5	Categorize the Technical concepts of Architecture & Mathematics	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	1	2	1
CO2	-	-	-	1	2	-
CO3	-	-	-	1	1	1
CO4	-	-	-	2	1	1
CO5	-	-	-	1	2	1
23EEACZ8	**-**	**-**	**-**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%