M.E. Environmental Engineering

CURRICULUM AND SYLLABI

I to IV Semesters

Regulation - 2020

ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

Accredited by NBA and NAAC with "A+"and Recognized by UGC (2f&12B)

KOMARAPALAYAM – 637303

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KOMARAPALAYAM - 637303

DEPARTMENT OF CIVIL ENGINEERING
M.E ENVIRONMENTAL ENGINEERING
REGULATION -2020
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULUM

SEMESTER I									
Code No.	Course	Category	Periods /Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course (s)									
20PMA102	Statistical Methods for Engineers	FC	3	2	0	4	40	60	100
20PEE101	Environmental Chemistry	FC	3	0	0	3	40	60	100
20PEE102	Environmental Microbiology	FC	3	0	0	3	40	60	100
20PEE103	Design of Physico- Chemical Treatment Systems	PC	3	0	0	3	40	60	100
20PEE104	Transport of Water and Wastewater	PC	3	0	0	3	40	60	100
Practical Course (s)									
20PEE105	Environmental Chemistry Laboratory	FC	0	0	4	2	50	50	100
20PEE106	Environmental Microbiology Laboratory	FC	0	0	4	2	50	50	100
Total			**15**	**2**	**8**	**20**	**300**	**400**	**700**

SEMESTER II									
Code No.	Course	Category	Periods /Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course (s)									
20PEE201	Design of Biological Treatment systems	PC	3	0	0	3	40	60	100
20PEE202	Industrial Wastewater Management	PC	3	0	0	3	40	60	100
20PEE203	Air and Noise Pollution Control Engineering	PC	3	0	0	3	40	60	100
20PEEEXX	Professional Elective I	PE	3	0	0	3	40	60	100
20PEEEXX	Professional Elective II	PE	3	0	0	3	40	60	100
20PEEEXX	Professional Elective III	PE	3	0	0	3	40	60	100
Practical Course (s)									
20PEE204	Environmental Process Monitoring Laboratory	PC	0	0	6	3	50	50	100
Employability Enhancement Course EEC									
20PEE205	Seminar	EEC	0	0	2	1	100	0	100
Total			**18**	**0**	**8**	**22**	**340**	**460**	**800**

Passed by the board of Studies

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SEMESTER III									
Code No.	**Course**	**Category**	**Periods /Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course (s)									
20PEE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
Professional Elective									
20PEEEXX	Professional Elective IV	PE	3	0	0	3	40	60	100
20PEEEXX	Professional Elective V	PE	3	0	0	3	40	60	100
Employability Enhancement Course-EEC									
20PEE302	Project work (Phase I)	EEC	0	0	12	6	50	50	100
20PEE303	Industrial Training	EEC	(2 Weeks)			1	100	0	100
Total			**9**	**0**	**12**	**16**	**270**	**230**	**500**

SEMESTER IV									
Code No.	**Course**	**Category**	**Periods /Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Employability Enhancement Course-EEC									
20PEE401	Project work (Phase II)	EEC	0	0	24	12	50	50	100
Total			**0**	**0**	**24**	**12**	**50**	**50**	**100**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70

CREDITS SUMMARY

S.No	CATEGORY	CREDITS PER SEMESTER				TOTAL CREDIT	CREDITS IN %
		I	II	III	IV		
1	**FC**	14				14	**20.0**
2	**PC**	6	12	3		21	**30.0**
3	**PE**		9	6		15	**21.4**
4	**EEC**		1	7	12	20	**28.6**
Total		20	22	16	12	70	**100.00**

FC - Foundation Course
PC - Professional Core
PE - Professional Electives
EEC - Employability Enhancement Courses

MC - Mandatory Courses (Non-Credit Courses)
CA - Continuous Assessment
FE - Final Examination

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PROFESSIONAL ELECTIVES I ,II& III									
SEMESTER II									
Sub code	**Course**	**Category**	**Periods /Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20PEEE01	Ecological Engineering	PE	3	0	0	3	40	60	100
20PEEE02	Solid and Hazardous Waste Management	PE	3	0	0	3	40	60	100
20PEEE03	Operation and Maintenance of Treatment Systems	PE	3	0	0	3	40	60	100
20PEEE04	Environmental Policy and Legislation	PE	3	0	0	3	40	60	100
20PEEE05	Environmental Quality Monitoring	PE	3	0	0	3	40	60	100
20PEEE06	Climate change and adaptation	PE	3	0	0	3	40	60	100
20PEEE07	Marine Pollution and Control	PE	3	0	0	3	40	60	100

PROFESSSIONAL ELECTIVES IV & V									
SEMESTER III									
Sub code	**Course**	**Category**	**Periods /Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20PEEE11	Air and Water Quality Modeling	PE	3	0	0	3	40	60	100
20PEEE12	Membrane Separation for Water and Wastewater Treatment	PE	3	0	0	3	40	60	100
20PEEE13	Computing Techniques in Environmental Engineering	PE	3	0	0	3	40	60	100
20PEEE14	Landfill Engineering and Remediation Technology	PE	3	0	0	3	40	60	100
20PEEE15	Environmental Risk Assessment	PE	3	0	0	3	40	60	100
20PEEE16	Remote Sensing and GIS Applications in Environmental Management	PE	3	0	0	3	40	60	100
20PEEE17	Environmental Impact Assessment	PE	3	0	0	3	40	60	100

20PMA102	Statistical Methods for Engineers	L	T	P	C
		3	2	0	4
Nature of Course	Basic science				
Pre requisites	Advanced mathematics				

Course Objectives

The course is intended

1. To study and understand the concepts of Statistical methods and its applications in Engineering.
2. To study the effect of estimation theory, testing of hypothesis, correlation and regression, randomized Design, and multivariate analysis.
3. To identify the strength and direction of a linear relationship between two variables and using regression to predict how much a dependent variable changes based on the adjustments to an independent variable
4. To learn how to plan, design and conduct experiments effectively and analyze the resulting data to obtain objective conclusions
5. To find the patterns and relationship between several variables simultaneously. It let us predict the effect a change in one variable will have in another variable

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Solve various problems in the field of engineering employing probability and statistical methods	Understand
CO2	Identify, formulate, and solve environmental engineering problems using the techniques, skills, and modern engineering tools necessary for environmental engineering practice	Apply
CO3	Find professional level employment as Environmental Engineers or pursue higher studies	Apply
CO4	Function in multi-disciplinary teams and understand the ethical and professional responsibility	Apply
CO5	Apply the effect of estimation theory, testing of hypothesis, correlation and regression, randomized design, and multivariate analysis.	Apply

Course Contents:

Unit- I Estimation Theory **12**

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

Unit- II Testing of Hypothesis **12**

Tests based on Normal, t, X2 and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

Unit – III Correlation and Regression **12**

Multiple and Partial Correlation – Method of Least Squares – Plane of Regression – Properties of Residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations– Regression and Partial correlations in terms of lower order coefficient.

Unit- IV Design Of Experiments **12**

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

Unit- V Multivariate Analysis **12**

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

Total: 60 Periods

Passed by the board of Studies

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Reference Books:

1. Gupta.S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons,11th Edition,2002
2. J.E. Freund, Mathematical Statistical", , Prentice Hall of India 5th Edition,2001.
3. Jay L.Devore, "Probability and statistics for Engineering and the Sciences", , Thomson and Duxbury, Singapore, 5th Edition 2002
4. Murray.R. Spiegel and Larry J.Stephens, "Schaum'souTlines- Statistics", , Tata McGraw-Hill,3rd Edition 2000
5. R.A.Johnson and C.B.Gupta, "Miller & Freund"s Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition,2007
6. Richard A.Johnson and Dean W.Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition,2007

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**Pos**										**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	2	3								1	3	1
CO2	3	3	2	3								1	3	1
CO3	3	3	2	3								1	3	1
CO4	3	3	2	3								1	3	1
CO5	3	3	2	3									3	1
	3	High				2	Medium				1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	20	20	20	40
Analyse	0	0	0	0
Evaluate	10	10	10	20
Create	0	0	0	0

20PEE101	Environmental Chemistry	L	T	P	C
		3	0	0	3
Nature of Course	Foundation Course				
Pre requisites	NIL				

Course Objectives

The course is intended

1. To educate the students in the area of water, air and soil chemistry
2. To impart knowledge on the transformation of chemicals in the environment
3. To gain knowledge on atmospheric chemistry
4. To understand the nature and composition of soil
5. To acquire knowledge on environmental chemicals

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To understand the essential theoretical background of the principles of chemistry applied to the solutions of environmental problems.	Understand
CO2	To apply the principles of chemistry in solving water and wastewater treatment problems.	Apply
CO3	To analyses the chemistry related issues in water and wastewater treatment.	Analyse
CO4	To evaluate the characteristics of raw water, treated water, products of biodegradation of wastewaters and the performance of different units of water and wastewater treatment.	Apply
CO5	To impart knowledge on the transformation of chemicals in the environment	Apply

Course Contents:

Unit- I Introduction **9**

Stoichiometry and mass balance-Chemical equilibrium, acid base, solubility product (Ksp) ,heavy metal Precipitation, hydroxides, CO2 solubility in water and species Distribution – Chemical kinetics , First order- 12 Principles of green chemistry**.**

Unit- II Aquatic Chemistry **9**

Water quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation- Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation ..

Unit- III Atmospheric Chemistry **9**

Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion- greenhouse gases and global warming, CO2 capture and sequestration – Acid rain- origin and composition of particulates Air quality parameters-effects and determination

Unit - IV Soil Chemistry **9**

Nature and composition of soil-Clays- cation exchange capacity-acid base and ion exchange reactions in soil -Agricultural chemicals in soil-Reclamation of contaminated land; salt by leaching-Heavy metals by electro kinetic remediation**.**

Unit- V Environmental Chemicals **9**

Heavy metals-Chemical speciation -Speciation of Hg &As- Organic chemicals- Pesticides, Dioxins, PCBs,PAHs and endocrine disruptors and their Toxicity- Nano materials, CNT, titania, composites ,environmental applications**.**

Total: 45 Periods

Passed by the board of Studies

Approved in Academic council

Reference Books:

1. Colin Baird„ Environmental Chemistry", Freeman and company, New York, 5th Edition,2012..
2. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, , New Delhi 5th Edition 2003.
3. Manahan, S.E., "Environmental Chemistry", , CRC press,9th Edition 2009.

Additional References:

1. Ronald A. Hites ,"Elements of Environmental Chemistry",Wiley, 2nd Edition,2012.
2. Web basedsources

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3									1	1		
CO2	3	3	3									1	1		
CO3	3	3	3									1	1		
CO4	3	3	3									1	1		
CO5	3	3	3									1	1		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE2 (7.5)**	**IAE 3 (10)**	
Remember	0	0	0	0
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	10	10	10	20
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE102	Environmental Microbiology	L	T	P	C
		3	0	0	3
Nature of Course	Foundation Course				
Pre requisites	NIL				

Course Objectives

The course is intended

1. To provide a basic understanding on microbiology relevant to environment
2. To outline the morphology, behavior and biochemistry of bacteria, fungi, protozoa, viruses, and algae
3. To provide The microbiology of wastewater, sewage sludge and solid waste treatment processes
4. To gain the knowledge on the pathogens in waste water
5. To provide an exposure to toxicology due to industrial products are also covered

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Have the basic understanding on the basics of microbiology and their diversity and on the genetic material in the living cell.	Understand
CO2	Understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.	Understand
CO3	Understand the role microbial metabolism in a wastewater treatment plant.	Understand
CO4	Know the role of microorganisms in a contaminated water and the diseases caused.	Apply
CO5	Conduct and test the toxicity due to various natural and synthetic products in the environment	Apply

Course Contents:

Unit- I Classification And Characteristics **9**

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology.

Unit- II Microbes And Nutrient Cycles **9**

Distribution of microorganisms - Distribution / diversity of Microorganisms - fresh and marine, terrestrial- microbes in surface soil, Air - outdoor and Indoor, aerosols, bio safety in Laboratory - Extreme Environment - archae bacteria - Significance in water supplies - problems and control. Transmissible diseases. Biogeochemical cycles-----Hydrological - Nitrogen, Carbon, Phosphorus, Sulphur, Cycle – Role of Microorganism in nutrient cycle.

Unit- III Metabolism Of Microorganisms **9**

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics

Unit- IV Pathogens In Wastewater **9**

Introduction to Water Borne pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens – Bacterial, Viral, Protozoan, and Helminthes, Indicator organisms of water – Coli forms - total coli forms, E- coli, Streptococcus, Clostridium, Concentration and detection of virus. Control of microorganisms; Microbiology of biological Treatment processes – aerobic and anaerobic, a-oxidation, β-oxidation, nitrification and gentrification, eutrophication. Nutrients Removal – BOD , Nitrogen, Phosphate. Microbiology of Sewage Sludge.

Unit - V Toxicology **9**

Eco toxicology – toxicants and toxicity, Factors influencing toxicity. Effects – acute, chronic, Test organisms – toxicity Testing, Bio-concentration – Bioaccumulation, biomagnifications, bioassay, bio-monitoring, bioleaching.

Total: 45 Periods

Reference Books:

1. Frank C. Lu and Sam Kacew, LU's" Basic Toxicology", Taylor & Francis, London 5thEdition ,2003
2. Hurst, C.J. Manual of "Environmental Microbiology". 3rd Edition. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 -X.2007
3. Grerard J. Tortora, Berdell R. Funke, Christine and L. Case. Microbiology: An Introduction.Benjamin Cummings, U.S.A.2004
4. Stanley E. Manahan, "Environmental Science and Technology", LewisPublishers.2000
5. Prescott, L.M., Harley, J.P. and Klein, D.A. Microbiology. McGraw Hill, Newyork2006.
6. SVS. Rana, "Essentials of Ecology and Environmental Science", 3rd revised Edition, Prentice Hall of India
   Private Limited,2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3									1	1		
CO2	3	3	3									1	1		
CO3	3	3	3									1	1		
CO4	3	3	3									1	1		
CO5	3	3	3									1	1		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE I (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE103	Design of Physico- Chemical Treatment Systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	NIL				

Course Objectives

The course is intended

1. To understand water and waste water characteristics
2. To gain knowledge on principles of treatment
3. To impart knowledge on the design of municipal water treatment plants
4. To acquire knowledge on industrial water treatment plants
5. To familiarize on design of waste water treatment plants

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Learn about water and wastewater characteristics and, fundamentals of water and wastewater treatment	Understand
CO2	Identify and understand the common physical and chemical unit operations encountered in treatment processes	Understand
CO3	Develop conceptual schematics required for the treatment of water and wastewater	Apply
CO4	Translate pertinent forcing criteria into physical and chemical treatment system.	Apply
CO5	Explain the principles of physicochemical processes and apply the knowledge in the process design of water and wastewater treatment	Apply

Course Contents:

Unit– I Introduction **5**

Pollutants in water and wastewater-characteristics, Standards for performance-Significance of physico-chemical treatment -Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics

Unit– II Treatment Principles **10**

Physical treatment- Screening -Mixing, Equalization -Sedimentation – Filtration -Evaporation-Incineration-gas transfer -mass transfer coefficient Adsorption-Isotherms-Membrane separation, Reverse Osmosis, nano filtration, ultra filtration and hyper filtration electro dialysis, distillation-stripping and crystallization- Recent Advances. Principles of Chemical treatment- Coagulation flocculation-Precipitation- flotation solidification and stabilization -Disinfection, Ion exchange, Electrolytic methods, Solvent extraction-advanced Oxidation/reduction- Recent Trends

Unit– III Design Of Municipal Water Treatment Plants **10**

Selection of Treatment-Design of municipal water treatment plant units-Aerators- chemical feeding-Flocculation-clarifier -tube settling-filters-Rapid sand filters, slow sand filter, pressure filter, dual media Disinfection- Displacement and gaseous type-Flow charts-Layouts-Hydraulic Profile ,PID-construction and O&M aspects-case studies, Residue management- Up gradation of existing plants – Recent Trends.

Unit– IV Design Of Industrial Water Treatment Plants **10**

Design of Industrial Water Treatment Units-Selection of process-Design of softeners-De mineralizes-Reverse osmosis plants-Flow charts-Layouts-Hydraulic Profile, PID-construction and O&M aspects-case studies, Residue management- Up gradation of existing plants -Recent Trends.

Unit– V Design Of Wastewater Treatment Plants **10**

Design of municipal wastewater treatment units-screens-detritors-grit chamber-settling tanks sludge thickening – sludge dewatering systems - sludge drying beds - Design of Industrial Wastewater Treatment Units - Equalization – Neutralization - Chemical Feeding Devices – mixers - floatation

units - oil skimmer Flowcharts – Layouts – Hydraulic Profile, PID, construction and O&M aspects - case studies, Retrofitting - Residue management - Up gradation of existing plants - Recent Trends.

Total: 45 Periods

Reference Books:

1. Metcalf & Eddy, Inc., G. Tchobanoglous, H. D. Stensel, R.Tsuchihashi, and F.L.Burton."Wastewater Engineering: Treatment and Resource Recovery" 5th Edition, McGrawHill
2. Qasim,S.R., Motley, E.M and Zhu.G. "Water works Engineering -Planning, Design and Operation", Indian reprit,Prentice Hall, New Delhi,2011.
3. CPHEEO Manual on Sewage and Sewage Treatment Systems Part A, B& C, Ministry of Urban Development Governmentr of Indain, New Delhi 2013
4. David Hendricks," Fundamentals of Water Treatment Process", CRC Press New York,2011.
5. Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw Hill, New York,1999. Spellman F.R. , "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York2009

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		2	1		3					3	1		
CO2	3	3		2	1		3					3	1		
CO3	3	3		2	1		3					3	1		
CO4	3	3		2	1		3					3	1		
CO5	3	3		2	1		3					3	1		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE104	Transport of Water and Wastewater	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	NIL				

Course Objectives

The course is intended

1. To understand the properties of fluids and flow measurements.
2. To impart knowledge on water transmission and distribution
3. To gain knowledge on wastewater collection and conveyance
4. To familiarize on storm water drainage
5. To understand the various software applications for the design of water and sewage network

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Identify and apply basic concepts of wastewater treatment for handling industrial wastewater	Understand
CO2	Select various pipe materials for water supply main, distribution network and sewer	Understand
CO3	Design water supply main, distribution network and sewer for various field conditions	Apply
CO4	Understand about sampling, quantification and analysis of industrial wastewater	Apply
CO5	Know troubleshooting in water and sewage transmission be able to use various computer software for the design of water and sewage network	Apply

Course Contents:

Unit– I General Hydraulics And Flow Measurement 8

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying Capacity-Flow measurement.

Unit– II Water Transmission And Distribution 12

Need for Transport of water and wastewater-Planning of Water System -Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps characteristics- economics; Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection Storage reservoirs.

Unit– III Wastewater Collection And Conveyance 10

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– IV Storm Water Drainage 8

Necessity- - combined and separate system; Estimation of storm water run-off Formulation of rainfall intensity duration and frequency relationships- Rational methods

Unit – V Case Studies And Software Applications 7

Use of computer software in water transmission, water distribution and sewer design – EPANET 2.0, LOOP version 4.0, SEWER, BRANCH, Canal ++ and GIS based software‟s.

Total: 45 Periods

Reference Books:

1. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. Manual on water supply and Treatment" , CPHEEO, Ministry of Urban Development, Government of India, NewDelhi,1999.
3. Bajwa, G.S. "Practical Handbook on Public Health Engineering", Deep Publishers, Shimla,2003

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	2			3					1	1		
CO2	3	3	3	2			3					1	1		
CO3	3	3	3	2			3					1	1		
CO4	3	3	3	2			3					1	1		
CO5	3	3	3	2			3					1	1		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE I (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE105	Environmental Chemistry Laboratory	L	T	P	C
		0	0	4	2
Nature of Course	Foundation Course				
Pre requisites	NA				

Course Objectives

The course is intended

1. To understand on quality control aspects
2. To impart knowledge on sampling of water
3. To familiarize on analysis of water
4. To understand the waste water analysis
5. To gain knowledge on sampling and characteristics of soil

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Familiarize on quality control aspects	Apply
CO2	Develop skills on the determination of physical and chemical characteristics of water and wastewater	Understand
CO3	Carry out the various treatment techniques for pollutant removal	Apply
CO4	Gain knowledge on simplifying of soil	Understand
CO5	Acquire knowledge on characteristics of soil	Understand

S.No	List of Exercises	CO Mapping	RBT
1	Good Laboratory Practices, Quality control and calibration	CO1	Understand
2	Sampling and Analysis of water (pH, alkalinity, hardness, chloride, Sulphate , turbidity EC, TDS,TS, nitrate, fluoride)'	CO2	Understand
3	Wastewater analysis (BOD, COD, Phosphate, TKN, Oil & Grease, Surfactant and heavy metals).	CO2	Understand
4	Sampling and characterization of soil (CEC & SAR, pH and K).	CO4	Understand

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1		3			3			2					3	1	
2		3			3			2					3	1	
3		3			3			2					3	1	
4		3			3			2					3	1	
5		3			3			2					3	1	
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	30	30
Understand	70	70
Apply		
Analyze		
Evaluate		
Create		

20EE106	Environmental Microbiology Laboratory	L	T	P	C
		0	0	4	2
Nature of Course	Foundation Course				
Pre requisites	NA				

Course Objectives

The course is intended

1. To impart knowledge on microbial contamination
2. To acquire knowledgeable on toxicity
3. To gain knowledge on microbes in the contaminated environment
4. To familiarize on assay of enzymes involved in biotransformation
5. To understand the on effect of pesticides on soil microorganisms

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Gain knowledge on microbial contamination of water, wastewater and solid waste	Apply
CO2	Become knowledgeable on toxicity	Apply
CO3	Observe and identify the microbes in the contaminated environment	Apply
CO4	Identify assay of enzymes involved in biotransformation	Apply
CO5	Gain knowledge on effect of pesticides on soil microorganisms.	Understand

S.No	List of Exercises	CO Mapping	RBT
1	Preparation of culture media,	3	Understand
2	Isolation, culturing and Identification of Microorganisms	3	Understand
3	Microorganisms from polluted habitats (soil, water and air)	3	Understand
4	Measurement of growth of microorganisms,	1	Understand
5	Assay of enzymes involved in biotransformation	2	Understand
6	Biodegradation of organic matter in waste water	1	Understand
7	Analysis of air borne microorganisms,	3	Understand
8	Staining of bacteria	3	Understand
9	Effect of pH, temperature on microbial growth	1	Understand
10	Pollutant removal using microbes from industrial effluent.	2	Understand
11	Effect of pesticides on soil microorganisms.	2	Understand

12	Bacteriological analysis of wastewater (Coliforms, *E.coli, Streptococcus*) – MPN	3	Understand
13	Bacteriological analysis of wastewater (Coliforms, *Streptococcus)* - MF techniques, Effect of Heavy metals on microbial growth.	3	Understand
14	Detection of Anaerobic bacteria (*Clostridium* sp.)	3	Understand
15	Bioreactors(cultivation of microorganisms)	1	Understand

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1		3			3			2					3	1	
2		3			3			2					3	1	
3		3			3			2					3	1	
4		3			3			2					3	1	
5		3			3			2					3	1	
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	30	30
Understand	70	70
Apply		
Analyze		
Evaluate		
Create		

20PEE201	Design of Biological Treatment System	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	NA				

Course Objectives

The course is intended

1. To educate the students on the principles and process designs of various treatment systems for water and wastewater
2. To familiarize on aerobic treatment of waste water
3. To impart knowledge on anaerobic treatment of waste water
4. To gain knowledge on sludge treatment and disposal
5. To acquire knowledge on construction operation and maintenance aspects

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Develop conceptual schematics required for biological treatment of wastewater	Understand
CO2	Translate pertinent criteria into system requirements.	Apply
CO3	Acquire knowledge on the design of suspended growth treatment plants	Apply
CO4	Design sludge digestion and disposal	Apply
CO5	Analyse the problems related to troubleshooting of the wastewater treatment plant and to apply the corrective measures for the same.	Analyse

Course Contents:

Unit- I Introduction **9**

Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type.

Unit- II Aerobic Treatment of Wastewater **9**

Design of sewage treatment plant units –Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems, constructed wet land – Disinfection – disposal options – reclamation and reuse – Flow charts, layout, PID, hydraulic profile, recent trends.

Unit- III Anaerobic Treatment of Wastewater **9**

Attached and suspended growth, Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal – Nutrient removal systems – Flow chart, Layout and Hydraulic profile - Recent trends.

Unit – IV Sludge Treatment and Disposal **9**

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, and sludge Dewatering (mechanical and gravity) Layout, PID, and hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.

Unit - V Construction Operations and Maintenance Aspects **9**

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organizing and

controlling of plant operations – capacity building - Retrofitting Case studies – sewage treatment plants – sludge management facilities.

Total: 45 Periods

Reference Books:

1. Metcalf & Eddy, Inc., G. Tchobanoglous, H. D. Stensel, R. Tsuchihashi, and F. L.Burton. "Wastewater Engineering: Treatment and Resource Recovery. McGraw HillCompany. "5th edition 2014.
2. Qasim, S. R. "Wastewater Treatment Plant, Planning, Design & Operation", , CRC press, New York, 2nd edition 2010.
3. ArceivalaS.J.,andAsolekarS.R"WastewaterTreatmentforPollutionControlandreuse„TataMcGraw Hill, , New Delhi, 3rd Edition 2007.
4. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press, New York2011.
5. F.R. Spellman, "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York2009.
6. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi,2013.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3				2	3					3	3	1
CO2	3	3				2	3					3	3	1
CO3	3	3				3	3					3	3	1
CO4	3	3				3	3					3	3	1
CO5	3	3				2	3					3	3	1
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	0	0	0	0
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	10	10	10	20
Evaluate	0	0	0	0
Create	0	0	0	0

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20PEE202	Industrial Wastewater Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	NA				

Course Objectives

The course is intended

1. To impart knowledge on the concept and application of Industrial Pollution prevention, cleaner technologies, industrial wastewater treatment and residue management
2. To Understand principles of various processes applicable to industrial Wastewater treatment
3. To identify the best applicable technologies for wastewater treatment from the Perspective of yield production.
4. To acquire knowledge on reuse of waste water and residual management
5. To gain knowledge on waste water characteristics

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Define the Principles of pollution prevention and mechanism of oxidation processes.	Understand
CO2	Suggest the suitable technologies for the treatment of wastewater.	Apply
CO3	Carry out the qualitative and quantitative assessment of industrial wastewater	Apply
CO4	Design the treatment systems	Apply
CO5	Discuss about the wastewater characteristics	Apply

Course Contents:

Unit- I Introduction **9**

Industrial scenario in India- Industrial activity and Environment - Uses of Water by industry Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling – generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.

Unit- II Industrial Pollution Prevention &Waste minimization **9**

Prevention vis a vis Control of Industrial Pollution Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimization Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries.

Unit- III Industrial waste water treatment **9**

Flow and Load Equalization – Solids Separation – Removal of Fats Oil & Grease- Neutralization - Removal of Inorganic Constituents- Precipitation, Heavy Metal removal, Nitrogen & Phosphorus removal, Iron exchange, Adsorption, Membrane Filtration Eletrodialysis & Evaporation – Removal of Organic Constituents – Biological treatment Process, Chemical Oxidation Processes, Advanced Oxidation processes- Treatability studies.

Unit – IV Wastewater Reuse And Residual Management **9**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion,

conditioning, dewatering and disposal of sludge – Management of RO rejects

Unit- V Casestudies **9**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining-Pharmaceuticals-Sugar and Distilleries

Total: 45 Periods

Reference Books:

1. "Industrial wastewater management, treatment & disposal, Water Environment" Alexandria Virginia,3rdEdition,2008.
2. Waste water Treatment for pollution control and reuse by Soli. J. Arceivala, Shyam. R. Asolekar, Tata Mcgraw Hill, 2007
3. LawranceK.Wang,YungTse Hung,Howard. Lo and ConstantineYapijakis"hand look of Industrial and Hazardous wasteTreatment",SecondEdition,2004
4. Metcalf & Eddy/ AECOM, "Water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies,2007
5. Nelson Leonard Nemerow, " Industrial waste Treatment", Elsevier,2007.
6. Paul L. Bishop, „Pollution Prevention: - Fundamentals and Practice", Mc-GrawHill International, Boston,2000

Additional References:

1. http://nptel.ac.in/courses/2009-12-31/
2. Comprehensive Industry Document Series, Central Pollution Control Board, New Delhi,India
3. Web based sources

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	3	3				3				3		1
CO2	3	3	3	3				3				3		1
CO3	3	3	3	3				3				3		1
CO4	2	3	3	3				3				3		1
CO5	2	3	3	3				3				3		1
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE203	Air and Noise Pollution Control Engineering	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Basic Science				

Course Objectives

The course is intended

1. To understand the sources and classification of air pollutants
2. To gain knowledge on monitoring air pollution and modeling
3. To apply these concepts to Air and noise Pollution Control and Environmental Management
4. To acquire knowledge on the control of gaseous contaminants
5. To familiarize on automobile and noise pollution

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Enumerate the Sources and Classification of air pollutants	Knowledge
CO2	Explain the Air pollution monitoring and modeling	Understand
CO3	Illustrate the control of particulate contaminants	Analysis
CO4	Illustrate the control of gaseous contaminants	Analysis
CO5	Understand the importance of air and noise pollution.	Understand

Course Contents:

Unit- I Introduction **7**

Structure and composition of Atmosphere – Sources and classification of air pollutants - Effects of air pollutants on Human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water –Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission – Air Pollution Indices – Emission Inventories.

Unit - II Air Pollution Monitoring and Modeling **7**

Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport &Dispersion of Air Pollutants – Modeling Techniques – Air Pollution Climatology.

Unit- III Control of Particulate Contaminants **10**

Factors affecting Selection of Control Equipment – Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Considerations - Process Control and Monitoring – Costing of APC equipment – Case studies for stationary and mobile sources.

Unit- IV Control Of Gaseous Contaminants **10**

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations - Costing of APC Equipment – Case studies for stationary and mobile sources**.**

Unit - V Automobile and Noise Pollution **11**

Vehicular Pollution: Automobile emission- Types of emissions- Exhaust emissions, evaporative emissions, crank-case emissions- Prevention and control of vehicular pollution. Noise Pollution: Sources and Effects of Noise Pollution – Measurement – Standards – Control and Preventive measures. Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control.

Total: 45 Periods

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Reference Books:

1. Anjaneyulu. Y, “Air Pollution & Control Technologies” Allied Publishers (P) Ltd.,India,2002.
2. ArthurC.Stern,„Air Pollution (Vol.I-Vol.VIII)“, Academic Press, 2006.
3. Daniel Vallero“ Fundamentals of Air Pollution”, FourthEdition,2008.
4. DavidH.F.Liu, BelaG. Liptak„AirPollution“,LweisPublishers, 2000.
5. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo,2004.
6. Noel de Nevers, "Air Pollution Control Engg"., Mc Graw Hill, New York,1995.
7. WayneT.Davis, „AirPollutionEngineering Manual“,JohnWiley&Sons, Inc.,2000.

Additional References:

1. https://nptel.ac.in/courses/105104099/ Environmental Air Pollution
2. https://nptel.ac.in/courses/105101087/03-Ltexhtml/p6/p.html NoisePollution

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		1			1		1			1	1	
CO2	3	2	2		2			1		1			1	2	
CO3	3	2	2		3			2		2			2	2	
CO4	3	2	2		3			2		2			2	2	
CO5	3	2	2		2			3		2			3	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE204	Environmental Processes Monitoring Laboratory	L	T	P	C
		0	0	6	3
Nature of Course	Professional Core				
Pre requisites	Waste Water Engineering				

Course Objectives

The course is intended

1. To develop knowledge coagulation, flocculation , settling
2. To impart knowledge on filtration and softening
3. To gain knowledge about the saturation index
4. To familiarize about the interpret about sludge test
5. To gain knowledge about tge ambience level

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Understand about basics of coagulation, flocculation , settling	Understand
CO2	Analyse about filtration and softening	Apply
CO3	Understand about saturation index	Understand
CO4	Interpret about Sludge test	Understand
CO5	Analyse ambience level	Apply

Course Content

S.No	List of Experiments	CO MAPPING	RBT
1.	Coagulation and Flocculation	CO1	Understand
2.	Batch studies on settling	CO1	Understand
3.	Studies on Filtration-Characteristics of Filter media	CO2	Apply
4.	Water softening	CO2	Apply
5.	Adsorption studies/Kinetics	CO2	Apply
6.	Langelier Saturation Index and Silt Density Index-For Membrane Filtration	CO3	Understand
7.	Kinetics of suspended growth process(activated sludge process)-and Sludge volume Index	CO3	Understand
8.	Sludge Filterability Test	CO4	Understand
9.	Anaerobic Reactor systems/kinetics(Demonstration)	CO4	Understand
10.	Advanced Oxidation Processes-(Photo catalysis)	CO5	Apply
11.	Disinfection for Drinking water (Chlorination)	CO2	Apply
12.	Ambient Air Sampling-Determination of PM10, PM2.5, SO2and NO2	CO5	Apply
13.	Noise Monitoring-Determination of Equivalent Noise Level	CO5	Apply

Total: 45 Periods

Reference Books:

1. AEESP Environmental Processes Laboratory Manual, Association of Environmental Engineering and Science Professors Foundation,Washington, 2002.
2. Aery N C., "Manual of Environmental Analysis", Ane Books Pvt. Ltd. New Delhi,2014
3. CPCB,Guidelines for the Measurement of Ambient Air Pollutants, Volume I, CentralPollution Control Board, Ministry of Environment and Forests, Government of India, 2001
4. Lee,C.C.andShundarLin."Handbook of Environmental Engineering Calculations", McGrawHill, NewYork,1999.
5. Metcalf & Eddy, Inc., G.Tchobanoglous, H.D.Stensel, R.Tsuchihashi and L.Burton. "Wastewater Engineering Treatment and Resource Recovery" 5th edition. McGraw Hill Company. 2014

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes(PSOs)														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	2	3	2	2	1	2				2		3
CO2	2	3	3	3	3	2	1	2				2		3
CO3	3	3	2	2	2	2	1	2				3		3
CO4	3	3	2	3	3	2	1	2				2		3
CO5	3	3	2	3	3	2	1	2				2		3
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	30	30
Understand	70	70
Apply		
Analyze		
Evaluate		
Create		

20EE205	Seminar	L	T	P	C
		0	0	2	1
Nature of Course	Skill development				
Pre requisites	Communication English				

Course Objectives

The course is intended

1. To select a topic in Environmental Engineering in the area of intrest
2. To select a related literature as per the topic selected
3. To gain the knowledge on the subject area of intrest
4. To acquire the skills of written and oral presentation
5. To develop writing abilities for seminar and conference

Course Outcome

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

CO. No.	Course Outcome	Bloom's Level
CO1	Specialize in a specific technical topic in the emerging areas of Environmental Engineering	Understand
CO2	Develop skills by reviewing the related literature	Understand
CO3	Acquire knowledge on the specific area of intrest	Knowledge
CO4	Become knowledge and develop skills in written and oral presentation	Understand
CO5	Enhance the writing abilities for seminars and conference	Understand

Course Content

The students will work for two hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Environmental Engineering and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will defend their presentation. Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar

MappingofCourseOutcomes(COs)withProgrammeOutcomes(POs)ProgrammeSpecificOutcomes(PSOs)														
COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3		3			1					2		3
CO2	3	3		3			1					2		3
CO3	3	3		3			1					2		3
CO4	3	3		3			1					2		3
CO5	3	3		3			1					2		3
	3	High				2	Medium					1	Low	

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Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	30	30
Understand	70	70
Apply		
Analyze		
Evaluate		
Create		

20PEE01	Ecological Engineering	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Ecology				

Course Objectives

The course is intended

1. To impart knowledge on the principles of ecological engineering that strengthen the functions of ecosystems
2. To understand the concept and application of ecological modeling
3. To familiarize the students with the basics of ecological engineering.
4. To gain knowledge on eco technology for waste treatment
5. To acquire knowledge from the case studies of integrated ecological energy system

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Gain knowledge about Ecosystems and Eco technology	Knowledge
CO2	Explain the structural and functional interactions of Environmental systems.	Understand
CO3	Illustrate the interface coupling in Ecological systems.	Analysis
CO4	Illustrate about Eco technology for Waste treatment	Analysis
CO5	Understand the Case studies of Integrated Ecological Engineering Systems	Understand

Course Contents:

Unit- I Ecosystems & Eco technology **10**

Aim, scope and applications of ecology – Development and evolution of eco systems – Principles and concepts pertaining to communities in eco system – Energy flow and material cycling in eco systems – productivity in eco systems.

Unit - II Systems Approach In Ecological Engineering **10**

Principles, components and characteristics of systems – Classification of systems – Structural and functional interactions of environmental systems – Environmental systems as energy systems – Mechanisms of steady-state maintenance in open and closed systems – Modeling and eco technology – Elements modeling – Modeling procedure – Classification of ecological model s- Applications of models in eco technology – Ecological economics.

Unit- III Ecological Engineering Processes **8**

Self-organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.

Unit - IV Ecotechnology For Waste Treatment **12**

Ecological engineering and eco technology – Classification of eco technology – Principles of ecological engineering. Eco sanitation - Principles and operation of soil infiltration systems – Wetlands and ponds – source separation systems – Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes – Applications of ecological engineering for marine systems.

Unit- V Case Studies **5**

Case studies of Integrated Ecological Engineering Systems and their commercial prospects.

Total: 45 Periods

Passed by the board of Studies

CHAIRMAN - BOARD OF STUDIES

Approved in Academic council

Reference Books:

1. Mitsch, W.J. Ecological Engineering and Ecosystem Restoration, Wiley 2nd Edition,2003
2. White I.D., Mottershed, D.N. and Harisson, S.J. Environmental systems – An Introductory text, Chapman Hall, London,1994
3. Jorgensen, S.E. Ecological Engineering: Principles and Practice. CRC Press,2003
4. Mitsch, J.W. and Jorgensen, S.E. Ecological Engineering – An Introduction to Eco technology, John Wiley & Sons, New York,1989.

Additional References:

1. Ecological Engineering for Wastewater Treatment, Etnier, C. and Guterstam, B., Lewis Publishers, New York,2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2		1			1		1				1	
CO2	3	2	2		2			1		1				2	
CO3	3	2	2		3			2		2				2	
CO4	3	2	2		3			2		2				2	
CO5	3	2	2		2			3		2				2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE02	Solid and Hazardous Waste Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Ecology				

Course Objectives

The course is intended

1. To understand sources, classification and regulatory framework in solid and hazardous waste
2. To impart knowledge on waste characterization and sources reduction
3. To gain knowledge on storage collection and transport of wastes
4. To understand the waste process technologies
5. To familiarize on waste disposal

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Know about the sources, classification and regulatory formwork	Knowledge
CO2	Understand the characteristics of different types of solid and hazardous wastes and the factors affecting variation	Understand
CO3	Define and explain important concepts in the field of solid waste management and suggest suitable technical solutions for treatment of municipal and industrial waste	Analysis
CO4	Understand the role legislation and policy drivers play in stakeholders' response to the waste and apply the basic scientific principles for solving practical waste management challenges	Analysis
CO5	Design the different elements of waste management systems.	Understand

Course Contents:

Unit- I Sources, Classification and Regulatory Framework **9**

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management –- Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes, plastics and fly ash -Elements of integrated waste management and roles of stakeholders - Financing and Public Private. Participation for waste management- Integrated solid waste management.

Unit- II Waste Characterization and Source Reduction **8**

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes -Waste exchange - Extended producer responsibility - Recycling and reuse

Unit- III Storage, Collection and Transport Of Wastes **9**

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection Systems - Need for transfer and transport – Transfer stations Optimizing waste allocation- compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

Unit- IV Waste Processing Technologies **10**

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes- treatment of biomedical wastes - Health considerations
in the context of operation of facilities.

Unit – V Waste Disposal **9**

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site

selection –design and operation of sanitary landfills, secure landfills and landfill bioreactors – *leachate* and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps-remediation of contaminated sites

Total: 45 Periods

Reference Books:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York,1993.
2. John Pitchtel,Waste Management Practices, CRC Press, Taylor and FrancisGroup,2014.
3. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, NewYork,2010.
4. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2014.
5. Frank Kreith, George Tchobanoglous, Handbook of Solid Waste management, McGraw Hill, 2002.

Additional References:

1. William A. Worrell, P. AarneVesilind, Solid Waste Engineering, Cengage Learning, 2012.
2.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2					1	1				1	1	
CO2	3	2	2					1	1				1	2	
CO3	3	2	2					2	1				2	2	
CO4	3	2	2					2	1				2	2	
CO5	3	2	2					3	2				3	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE03	Operation and Maintenance of Treatment Systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Methods of Treatment Systems				

Course Objectives

The course is intended

1. To understand the elements of operation and maintenance of water treatments
2. To impart knowledge on operation and maintenance of water intake and supply system
3. To gain knowledge on operation and make of sewer system
4. To understand the operation and maintenance of physico chemical treatments units
5. To familiarize on operation and maintenance of biological treatment

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Gain knowledge about to operate and maintain water treatment plants and wastewater treatment plants	Knowledge
CO2	Understand the operation and maintenance of water supply systems	Understand
CO3	Understand the operation and maintenance of sewer systems	Understand
CO4	Understand the operation and maintenance of physico-chemical treatment units	Understand
CO5	Explain the operation and maintenance of biological treatment	Understand

Course Contents:

Unit- I Elements Of Operation And Maintenance **9**

Strategy for Good Operation and Maintenance- Knowledge of process and equipment- Preventive and Corrective maintenance scheduling- - Operation and Maintenance Plan - Proper and adequate tools, Spare units and parts –Training Requirements- Laboratory control- Records and Reports- Housekeeping - Corrosion prevention and control – Sampling procedure-Analytical techniques- Code of practice for analytical laboratories- Measurement of Flows, Pressures and Levels -Safety in O&M Operations - Management Information System - Measures for Conservation of Energy- management of residues from plant maintenance

Unit- II Operation And Maintenance Of Water Intakes And Supply Systems **9**

Operational problems, O&M practices and Records of Operation of Reservoir and Intakes - Causes of Failure of Wells- Rehabilitation of Tube wells & Bore Wells- Prevention of Incrustation and Corrosion- Maintenance of Lined and Unlined Canals- Problems in Transmission Mains- Maintenance of Pipelines and Leakage Control- Repair Method for Different types of Pipes- Preventive and corrective maintenance of water pumps – Algal Control - O&M of Service Reservoirs - Problems in the water Distribution System and remedies- Water Quality Monitoring and Surveillance- Water Meters, Instrumentation, Telemetry & Scads- Computerized Water Billing System

Unit- III Operation And Maintenance Of Sewer Systems **9**

Components and functions of sewer system – Conduits or pipes – Manholes – Ventilating shaft – Maintenance of collection system – Operational Problems- Clogging of pipes – Hazards – Precautions against gas hazards – Precautions against infections – Devices for cleaning the conduits – Preventive and corrective maintenance of sewage pumps –operation and maintenance of sewage pumping stations- Maintenance Hazards and Operator Protection -Case Studies

Unit- IV Operation And Maintenance Of Physico-Chemical Treatment Units **9**

Operation and maintenance in screen chamber, Grit Chamber and clarifiers- - Operation issues, trouble shooting guidelines and record keeping requirements for clarifier, Equalization basins, Neutralization unit - Chemical storage and mixing equipment - Chemical metering equipment - Flash mixer –Filters, thickeners and centrifuges- Filter Press - Start- up and maintenance

inspection - Motors and Pumps - Hazards in Chemical Handling – Jar Test - Chlorination Equipment - Membrane process systems- SDI and LSI determination- Process Chemistry and Chemical dosage calculations- Case Studies

Unit- V Operation And Maintenance Of Biological Treatment **9**

Construction, Operation and Maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- Startup and Shutdown Procedures-DO, MLSS and SVI monitoring- Trouble shooting guidelines – Interaction with other Treatment Processes - Planning, Organizing and Controlling of plant operations – capacity building, case studies of Retrofitting-Case studies

Total: 45 Periods

Reference Books:

1. FrikSchutte, handbook for the operation of water Treatment Works,The Water Research Commission, The Water Institute of Southern Africa, TT265/06,2006.
2. Metcalf & Eddy, Inc., G. Tchobanoglous, H. D. Stensel, R. Tsuchihashi, and F. L.Burton. "Wastewater Engineering: Treatment and Resource Recovery"5th edition). McGraw HillCompany.,2014
3. Ananth S Kodavasal, The STP Guide-Design, Operation and maintenance, Karnataka State Pollution Control Board,Bangalore,2011
4. CPHEEO , Manual on operation and maintenance of water supply systems, Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, Government of India2005
5. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi, 2013.

Additional References:

1. Ministry of Drinking Water and Sanitation, operation and maintenance manual for rural water supplies, Government of India, 2013.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2					1	1			1	1	
CO2	3	2	2	3					1	1			1	2	
CO3	3	2	2	3					1	2			2	2	
CO4	3	2	2	3					1	2			2	2	
CO5	3	2	2	3					2	2			3	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE1 (7.5)	**IAE 2 (7.5)**	**IAE3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE04	Environmental Policy and Legislation	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Principles of Professional Ethics				

Course Objectives

The course is intended

1. To impart knowledge on national environmental policies
2. To gain knowledge on national environmental legislations and the polices for water
3. To familiarize on national environmental legislations and the polices for air
4. To acquire knowledge on national environmental legislation and policies for environment
5. To become knowledgeable on national environmental legislation and the policies for other acts

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Gain Knowledge about the general National environmental legislations and the policies	Knowledge
CO2	Get Knowledge about the National environmental legislations and the policies for Water	Knowledge
CO3	Gain Knowledge about the National environmental legislations and the policies for Air	Knowledge
CO4	Get Knowledge about the National environmental legislations and the policies for Environment	Knowledge
CO5	Knowledge about the National environmental legislations and the policies for other topics	Knowledge

Course Contents:

Unit- I Introduction 9

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

Unit- II Water (P&Cp) Act, 1974 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Unit- III Air (P&Cp) Act, 1981 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Unit- IV Environment (Protection) Act 1986 13

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

Unit- V Other Topics **7**

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

Total: 45 Periods

Reference Books:

1. Shyam Divan and Armin Roseneranz "Environmental law and policy in India "Oxford University Press, New Delhi,2001
2. GregerI.Megregor "Environmental law and enforcement", Lewis Publishers, London.1994
3. 1.CPCB "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi,1997

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2			1			1					1	1	
CO2	3	2			2			1					1	2	
CO3	3	2			3			2					2	2	
CO4	3	2			3			2					2	2	
CO5	3	2			2			3					3	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE05	Environmental Quality Monitoring	L	T	P	C
		3	0	0	3
Nature of Course	Basic Environmental Engineering				
Pre requisites	Environmental Engineering				

Course Objectives

The course is intended

1. To impart knowledge on environmental chemistry
2. To familiarize on spectroscopic methods
3. To gain knowledge on chromatographic methods
4. To acquire knowledge on Electro and Radio Analytical Methods
5. To become knowledgeable on continuous monitoring instruments

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Understand the environmental chemistry	Understand
CO2	Apply the methods for spectroscopic analysis	Apply
CO3	Analyse the methods of chromatographic methods	Analyse
CO4	Gain knowledge on Electro and Radio Analytical Methods	Analyse
C05	Differentiate the Principles, techniques and applications of NDIR analyzer	Analyse

Course Contents:

Unit- I Introduction **9**

Wet Chemistry methods and their limitations-Instrumental Methods, Selection of method Precision and Accuracy, Error in measuring signals-Quality control & assurance Sample preservation, Sample preparation and analyte isolation.

Unit- II Spectroscopic Methods **12**

Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace and hydride generation),Atomic Emission Spectrometry (AES) , flame and Inducted Coupled Plasma (ICP)-TOC Analyzer

Unit- III Chromatographic Methods **8**

Column, Paper and thin layer chromatography (TLC)-Principles, techniques and applications of GC, GC-MS, High performance liquid chromatography (HPLC) and Ion chromatograph (IC)-Hyphenated techniques for Environmental contaminant(trace organics) analysis.

Unit- IV Electro And Radio Analytical Methods **8**

Principles, techniques and applications of Conductometry, potentiometry, coulometry, AOX analyzer Amperometry, polarography, New Activation Analysis (NAA), X-ray Fluorescence (XRF)and X-ray Diffraction (XRD) methods.

Unit- V Continuous Monitoring Instruments **8**

Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOx Fluorescent analyzer for SO2 - Particulates analysis - Auto analyzer for water quality using flow injection analysis.

Total: 45 Periods

Reference Books

1. Barceló, D.(editor), "Environmental analysis. Techniques, Applications and Quality Assurance", Elsevier, The Netherlands,1996
2. Ewing Instrumental Methods of Chemical Analysis, 5th Edition, McGraw Hill,NewYork.1985
3. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, andApplications, Marcel Dekker; 1 edition (May2001),
4. Reeve, R.N., "Introduction to Environmental Analysis", Analytical Techniques in theSciences, John Wiley & Sons, Chichester, UK,2002.
5. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. „Instrumental methods of analysis Edn.Words Worth, New York,2004.

MappingofCourseOutcomes(COs)withProgrammeOutcomes(POs)ProgrammeSpecific Outcomes(PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	3	2			2	1					2		3	
CO2	2	3	2			2	2					2		2	
CO3	3	2	2			2	1					2		3	
CO4	3	3	2			2	1					2		3	
CO5	3	3	2			2	1					2		3	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE06	Climate Change and Adaptation	L	T	P	C
		3	0	0	3
Nature of Course	Basic Science				
Pre requisites	Environmental Science				

Course Objectives

The course is intended

1. To impart knowledge on types of climatic conditions
2. To gain knowledge on changes in climate
3. To familiarize on the impact of climatic changes
4. To acquire knowledge on climatic mitigation measurements
5. To become knowledgeable on clean technology

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Describe about types of climatic conditions	Understand
CO2	Understand about climate changes	Understand
CO3	Gain knowledge on the impact of Climatic Changes	Knowledge
CO4	Interpret the climatic mitigation measurements	Understand
CO5	Understand the Clean Technology	Understand

Course Contents:

Unit- I Earth's Climate System **9**

Introduction-Climate in the spot light-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 – ElNino 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**

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**

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**

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 – Carbons equestration – Carbon capture and storage(CCS) – Waste (MSW & Bio waste, Bio medical, Industrial waste –International and Regional cooperation.

Unit- V Clean Technology And Energy **9**

Clean Development Mechanism – Carbon Trading – examples of future Clean Technology – Bio diesel –Natural Compost – Eco – Friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar

Energy – Wind –Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.

Total: 45 Periods

Reference Books

1. Alcore „in convenient truth " – videoform
2. Dash Sushil Kumar, "Climate Change –An Indian Perspective", Cambridge University Press India Pvt.Ltd, 20073.
3. IPCC Fourth Assessment Report –The AR4 SynthesisReport,
4. JanC.van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press,2003

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes(PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3			2		1					2		3
CO2	3	3			3		1					2		3
CO3	3	3			3		1							
CO4	3	3			3		1					2		3
CO5	3	3			3		1					2		3
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE07	Marine Pollution and Control	L	T	P	C
		3	0	0	3
Nature of Course	Pollution Control				
Pre requisites	Waste Water Engineering				

Course Objectives

The course is intended

1. To impart knowledge on the Marine and Coastal Environment
2. To gain knowledge on ocean hydro dynamics
3. To acquire knowledge on marine pollution sources and effects
4. To familiarize on methods of pollution monitoring
5. To become knowledgeable on coastal management

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level
CO1	Gain knowledge on the marine & Coastal environment	Understand
CO2	Attain knowledge on ocean hydrodynamics	Knowledge
CO3	Identify the pollution sources & effects	Understand
CO4	Interpret the methods for pollution monitoring	Apply
CO5	Evaluate the method for coastal management	Evaluate

Course Content

Unit - I Marine and coastal Environment **9**

Seas and oceans, Continental area, Coastal zone, Properties of sea water, Principles of Marine Geology, coastal features-Beaches, Estuaries, Lagoons-The oceans and climate

Unit- II Ocean Hydro Dynamics **9**

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 Niño effect.

Unit - III Marine Pollution Sources And Effects **9**

Sources of Marine Pollution-Point and non-point sources, Pollution caused by Oil Exploration, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems-Marine discharges and effluent standards.

Unit- IV Marine Pollution Monitoring **9**

Basic measurements-Sounding boat, lead lines, echo sounders-current meters-tide gauge-use of GPS- Measurement of coastal water characteristics-sea bed sampling-Modeling of Pollutant transport and dispersion- Oil Spill Models-Ocean Monitoring satellites-Applications of Remote Sensing and GIS in monitoring marine pollution

Unit- V Coastal Management **9**

Pollution Control strategies-Selection of optimal Outfall locations-National and International Treaties, Coastal Zone Regulation-Total Maximum Daily Load applications-Protocols in Marine Pollution-ICZM and Sustainable Development

Total: 45 Periods

Reference Boos:

1. Laws, E.A., "Aquatic pollution", an introductory text. John Wiley and Sons, Inc., New York,2000.
2. 2."Marine Pollution R.B. Clark, C. Frid and M Atttrill, Oxford Science Publications,5thEdition, 2005.
3. 3.Marine pollution Dr.P. C.Sinha , Anmol Publications Pvt. Ltd, 1998.Marine Pollution: New Research-Tobias N. Hofer, Nova Publishers,2008
4. PracticalHandbookofEstuarineandMarinePollution,MichaelJ.Kennish,Volume10 CRCMarineScience, CRCPress,1996

MappingofCourseOutcomes(COs)withProgrammeOutcomes(POs)ProgrammeSpecificOutcomes(PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3			2	2		2				2		3
CO2		3						2						1
CO3	3	3			3	2						2		2
CO4	3				3	2		2				2		3
CO5	3	3			3	2		2				2		3
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

20PEE301	Research Methodology And Intellectual Property Rights (Common to all branches of PG)	L	T	P	C
		3	0	0	3
Nature of Course	Professional core				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Impart knowledge and skills required for research problem formulation
2. Identify the relevant literatures for research
3. Expose the skills on technical paper writing / presentation without violating professional ethics
4. Acquire knowledge on IPR and patents.
5. Gain knowledge on patent rights and Patent information database

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Identify and formulate research problem	Apply
CO2	Describe the literatures related to research problem.	Understand
CO3	Implement the effective methods to write a standard technical paper and make presentation.	Apply
CO4	Execute the correct procedure for applying patents	Apply
CO5	Familiarize on patent rights, licensing and transfer of technology.	Understand

Course Contents:

Unit- I Research Problem Formulation **9**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Unit- II Literature Review **9**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

Unit - III Technical Writing /Presentation **9**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, Latex Programming ,a presentation and assessment by a review committee.

Unit- IV Introduction to Intellectual Property Rights (IPR) **9**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, Research Hypothesis, Innovation, patenting development, Citation, International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit- V Intellectual Property Rights (IPR) **9**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs

Total: 45 Periods

Passed by Board of studies

CHAIRMAN - BOARD OF STUDIES

Approved in Academic Council

Reference Books:

1. Kothari, C.R." Research Methodology Methods and Techniques". 2nd Edition, New Age International Publishers, New Delhi 2004.
2. Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., " An introduction to Research Methodology", RBSA Publishers 2002
3. Sinha, S.C. and Dhiman, A.K.". Research Methodology", Ess Ess Publications. 2 volumes.2002
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3			3	3		3				3		2
CO2	3	3			3	3		3				3		2
CO3	3	3			3	3		3				3		2
CO4	3	3			3	3		3				3		2
CO5	3	3			3	3		3				3		2
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE- II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEE302	Project Work (Phase I)	L	T	P	C
		0	0	12	6
Nature of Course	Employability Enhancement Course				
Pre requisites	Knowledge in Environmental Engineering				

Course Objectives

The course is intended to

1. Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature
2. Analyze the identified problem.
3. Compare the current methodologies.
4. Propose a new methodology.
5. Conduct the preliminary test.

Course Outcomes

On successful completion of the Project Phase I, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Execute the clear idea of his/her area of work and carry out the remaining phase II work in a systematic way.	Apply
CO2	Identify the existing methodologies.	Understand
CO3	Analyze the merits and demerits of current methodologies.	Understand
CO4	Identify an efficient methodology.	Evaluate
CO5	Select a particular material based on specific properties.	Understand

Course Contents:

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.

Total: 180 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
Cos	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	3	3	3						3		3
CO2	3	3	3	3	3	3						3		3
CO3	3	3	3	3	3	3						3		3
CO4	3	3	3	3	3	3						3		3
CO5	3	3	3	3	3	3						3		3
	3	High				2	Medium					1	Low	

	Continuous Assessment [50 marks]						**Final Viva Voce Examination [50 marks]**
	Review I [10]	**Review II [10]**	**Review III [10]**	**Publication [10]**	**Report [10 Marks]**	**Total [50]**	
Marks	100	100	100	10	10	50	50

Passed by Board of studies

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20PEE303	Industrial Training	L	T	P	C
		0	0	0	1
Nature of Course	Employability Enhancement Course				
Pre requisites	Knowledge in structural engineering				

Course Objectives

The course is intended to

1. Train the student in the industry related to Environmental Engineering.
2. Develop skills in preparing the project report.
3. Compare the theoretical concepts and industrial applications.
4. Understand the practical difficulties and find suitable solutions
5. Get industrial exposure for various industrial projects

Course Outcomes

On successful completion of the Industrial training, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Solve the practical filed/ industry oriented problem related to Environmental Engineering.	Apply
CO2	Prepare an industrial project report.	Understand
CO3	Implement the technical concepts for industrial applications.	Apply
CO4	Interpret the practical difficulties and find the suitable solutions.	Apply
CO5	Describe the various types of individual projects.	Understand

Course Contents:

The students individually undertake training in reputed Industries during the summer vacation for a specified period of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1						2	3	2	3	1				2
CO2						2	3	2	3	1				2
CO3						2	3	2	3	1				2
CO4						2	3	2	3	1				2
CO5						2	3	2	3	1				2
	3	High				2	Medium					1	Low	

Assessment	Guide	Supervisor	Total Marks
Review I	20	20	100
Review II	20	20	
Report/Case study	-	20	

20PEE401	Project Work (Phase II)	L	T	P	C
		0	0	24	12
Nature of Course	Employability Enhancement Course				
Pre requisites	Knowledge in Environmental Engineering				

Course Objectives

The course is intended to

1. Conduct trial experiments.
2. Check the expected results
3. Continue the trials until the expected positive results are obtained
4. Preparation of preliminary report and discussion on test results
5. Arrive at conclusion and suggestion for future works

Course Outcomes

On successful completion of the Project Phase II, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Execute the trial experimental works	Apply
CO2	Correlate the experimental results and expected results	Knowledge
CO3	Prolong the experimental works for getting expected results	Apply
CO4	Prepare the experimental investigation report and comparison with related literature concepts	Knowledge
CO5	Conclude the results with suitable remarks and suggestion for further extension of work.	Knowledge

Course Contents:

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.

. **Total: 360 Periods**

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	3						3		3
CO2	3	3	3	3	3	3						3		3
CO3	3	3	3	3	3	3						3		3
CO4	3	3	3	3	3	3						3		3
CO5	3	3	3	3	3	3						3		3
	3	High				2	Medium					1	Low	

	Continuous Assessment [50 marks]						**Final Viva Voce Examination [50 marks]**
	Review I [10]	**Review II [10]**	**Review III [10]**	**Publication [10]**	**Report [10 Marks]**	**Total [50]**	
Marks	100	100	100	10	10	50	50

20PEEE11	Air and Water Quality Modeling	L	T	P	C
		3	0	0	3

Nature of Course	Professional Elective
Pre requisites	Knowledge in quality of air and water

Course Objectives

The course is intended to

1. Impart knowledge on modeling concepts.
2. Gain knowledge on water quality modeling.
3. Understand the concepts of air pollution modeling
4. Acquire knowledge on various types of modeling technique.
5. Understand the application of software package in air and water quality modeling

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the characteristics and steps in model development	Understand
CO2	Become knowledgeable in developing water quality models	Apply
CO3	Recognize chemistry of air pollutants and develop air pollution models	Apply
CO4	Select a techniques for developing non reactive pollutants models	Apply
CO5	Familiarize on developing air quality and water quality models by using software packages .	Apply

Course Contents:

Unit- I Modeling Concepts **9**

Casual and statistical models-Characteristics- Steps in model development - Importance of model building.- conservation of mass and mass balance –calibration and verification of models; Transport phenomena – Advection, diffusion, dispersion, simple transport models; chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

Unit- II Water Quality Modeling **9**

Water quality models – Historical development – Mass balance equation – Streeter - Phelps Equation – Modification to Streeter – Phelps Equation – Waste load allocations – Dissolved oxygen in Rivers and estuaries; Lake Water Quality Models; Models for Nitrogen, Bacteria, Phosphate and toxicants - Ground Water Quality Modeling - Contaminant solute transport equation, Numerical methods.

Unit - III Air Pollution Modeling **9**

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- IV Air Quality Models **9**

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 and stack design - receptor oriented and source oriented air pollution models- model performance, accuracy and utilization.

Unit- V Applications **9**

Software package applications: Air quality modeling and water quality modeling

Total: 45 Periods

Reference Books:

1. J.L.Schnoor, "Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc.,2nd Edition New York Wiley publication, 2007.
2. Steven C.Chapra, Surface Water Quality Modelling, The McGraw-Hill Companies, Inc., New Delhi, 2008.
3. Arthur C.Stern Air Pollution (3rd Ed.) Volume I – Air Pollutants, their transformation and Transport, (Ed.), Academic Press, 2006.
4. Deaton and Wine Brake, "Dynamic Modeling of Environmental Systems", Wiley & Sons, 2002.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2			2	2			2			2	
CO2	3	2	2			2	2			2			2	
CO3	3	2	2			2	2			2			2	
CO4	3	2	2			2	2			2			2	
CO5	3	2	2	3	3	2	2			2		3	2	
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE - II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE12	Membrane Separation for Water and Wastewater Treatment	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in quality of water and treatment				

Course Objectives

The course is intended to

1. Impart knowledge on membrane filtration process
2. Gain knowledge on design of membrane system
3. Acquire knowledge on design principles of membrane bioreactor.
4. Understand the methods and strategies of pretreatment
5. Become knowledgeable on the design of membrane based water and wastewater treatment system.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the various main membrane processes, principles, separation mechanisms and applications	Understand
CO2	Execute the design of membrane systems involving microfiltration, ultra filtration, nanofiltration reverse osmosis, electro dialysis and membrane bioreactor process	Apply
CO3	Apply the knowledge of science and engineering fundamentals to analyze the mechanism of membrane filtration	Apply
CO4	Describe the pretreatment methods and strategies	Understand
CO5	Conduct research pertinent to membrane technology application to water and wastewater.	Apply

Course Contents:

Unit- I Membrane Filtration Processes **9**

Solid Liquid separation systems- Theory of Membrane separation – mass Transport Characteristics- Cross Flow filtration - Membrane Filtration- Flux and Pressure drop -Types and choice of membranes, porous, non porous, symmetric and asymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

Unit- II Membrane Systems **9**

Microfiltration principles and applications – Ultra filtration principles and applications - Nano Filtration principles and applications – Reverse Osmosis: Theory and design of modules, assembly, plant process control and applications – Electro dialysis : Ion exchange membranes, process design- Pervaporation – Liquid membrane – Liquid Pertraction – Supported Liquid Membrane and Emulsion Liquid membrane - Membrane manufactures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection – Plant operations – Economics of Membrane systems

Unit - III Membrane Bioreactors **9**

Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

Unit- IV Pretreatment Systems **9**

Membrane Fouling – Control of Fouling and Concentration Polarisation - Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning, Biofoulant control.

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Unit- V Case Studies **9**

Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants – Desalination of brackish water.

Total: 45 Periods

Reference Books:

1. Symon Jud "Principles and application of MBR in water and wastewater treatment", Elservier, 2006.
2. Yamamoto K. and Urase T, "Membrane Technology in Environmental management",
   a. special issue, Water Science and technology, Vol.41, IWA Publishing, 2000 WEF,
   b. Membrane Bioreactors, WEF manual of Practice No.36, Water Environment Federation, USA.2012
3. Anthony Wachinski, Membrane Processes for water reuse, McGraw-Hill, USA, 2013
4. Baker, R.W., "Membrane technology and applications", 2nd Edition, John Wiley 2004

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
Cos	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	1					2		2				2
CO2	3	2	1	1	2	2								2
CO3	3	2	2			2								2
CO4	3	2	1		2			2	2	2				2
CO5	3	2	1	1			1					1		2
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE- II (7.5)**	**IAE -III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE13	Computing Techniques In Environmental Engineering	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in Environmental Engineering				

Course Objectives

The course is intended to

1. Educate the students to know about computing techniques
2. Gain knowledge on different numerical technique and logic like ANN, Fuzzy
3. Educate the students on various aspects of data management
4. Acquire knowledge on the model applications for monitoring and management of environment
5. Identify the modeling concepts using MATLAB.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the computing techniques	Understand
CO2	Apply the principle of soft computing for solving Environmental problems.	Apply
CO3	Assess the Environmental Impacts using ANN and Fuzzy logic.	Apply
CO4	Employ modern advanced computing tools in environmental studies	Apply
CO5	Acquire knowledge on Environmental Modeling Using MATLAB	Understand

Course Contents:

Unit- I Computing Principles **9**

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**

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**

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**

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**

Introduction to MATLAB Software – MATLAB applications in environmental – pollutants transport, decay and degradation modeling using MIKE 21 – MODFLOW - case studies.

Total: 45 Periods

Reference Books:

1. Data-Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering, Springer; 2014 edition.
2. Kotteguda, N.T., and Renzo Resso, Statistics, "Probability and Reliability for Civil and Environmental Engineers", McGraw Hill Companies Inc., New York, 2008.
3. Mathews J. H. and Fink K.D. , "Numerical methods using MATLAB", Pearson Education 2010.
4. Aliev R. A, and Aliev Rashad, "Soft Computing and its Applications", World Scientific Publications Co. Pte. Ltd. Singapore, 2014.
5. Chepra S. C. and Canele R. P., "Numerical Methods for Engineers", McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. 6th Edition 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	1											3
CO2	3	3	2	2	3			2		3		3		3
CO3	3	3	2			2		2		3		3		3
CO4	2	2	1				2	2			3			3
CO5	2	1				1	2		2	3				3
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE-II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE14	Landfill Engineering and Remediation Technology	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in Soil Mechanics				

Course Objectives

The course is intended to

1. Gain knowledge on basic of landfills
2. Impart knowledge on landfill liners and cover systems
3. Understand the concepts of leachate and landfill gas management
4. Acquire knowledge on landfill operation and closure
5. Become knowledgeable on contaminated site remediation

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Implement the Indian and international landfill regulations and guidelines for the design, construction, operation and management of landfills	Knowledge
CO2	Explain the design and construction of landfills, processes in landfills, methods for management and treatment of landfill gas and leachate	Understand
CO3	Interpret the key pollutants in leachate and gas, their potential environmental impacts and the engineering design and performance of control systems used to manage and treat pollutant and waste emissions from sites.	Apply
CO4	Identify the concepts of Landfill Construction and Operational Controls	Apply
CO5	Apply a risk based assessment of contaminated sites and implement site remediation technologies	Apply

Course Contents:

Unit- I Landfill Basics **8**

Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuration - Legal framework for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design -– Landfill Design Tasks.

Unit- II Landfill Liners and Cover Systems **10**

Design Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geo synthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design- liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geo membranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow- advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover - Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control

Unit - III Leachate and Landfill Gas Management **9**

Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of *Landfill* Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – Leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor

landfills- monitoring and control of leachate and Landfill gas- Landfill Settlement

Unit- IV Landfill Operation and Closure **9**

Landfill Construction and Operational Controls – Fill Sequencing Plans – Cell Construction- Dozer and Compactor operations-Selection of Landfill Equipment- Landfill Administration-Record Keeping- Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety- Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees

Unit- V Contaminated Site Remediation **9**

Contaminated sites - Fate and behaviour of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cut-off Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining

. **Total: 45 Periods**

Reference Books:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
2. Hari D Sharma and Krishna R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Techonolgies, John Wiely, New Jersy, 2004.
3. David E Daniel and Robert M. Koerner "Waste Containment Facilities -Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, American Socirty of Civil Engineers, ASCE Press.2007,
4. Donald L Wise and Debra J Trantolo, "Remediation of Hazardous Waste Contaminated Soils, Marcel Dekker Inc., New York,1994

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2			2	2					3	2	
CO2	3	2	2			2	2					3	2	
CO3	3	2	2			2	2					3	2	
CO4	3	2	2			2	2					3	2	
CO5	3	2	2			2	2					3	2	
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE- II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE15	Environmental Risk Assessment	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in Environmental pollution				

Course Objectives

The course is intended to

1. Impart knowledge on environmental and ecological risks.
2. Gain knowledge on fate and behavior of toxics and persistent substances in the environment.
3. Understand the tools and methods of risk assessment
4. Acquire knowledge on risk management
5. Become knowledgeable on risk management from case studies.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Identify the sources of environmental hazards	Knowledge
CO2	Identify fate and behavior of toxics and persistent substances in the environment.	Understand
CO3	Adopt HAZOP and FEMA methods based on the nature of risks	Apply
CO4	Apply the principle of risk management for solving Environmental problems	Apply
CO5	Select a methodology for risk assessment and management	Apply

Course Contents:

Unit- I Introduction **9**

Sources of Environmental hazards – Environmental and ecological risks – Environmental risk assessment framework – Regulatory perspectives and requirements – Risk Analysis and Management and historical perspective; Social benefit Vs technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines

Unit- II Elements of Environmental Risk Assessment **9**

Hazard identification and accounting – 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**

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 Risk Management **9**

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**

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, Chernobyl, Seveso, Three Mile Island.

Total: 45 Periods

Reference Books:

1. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
2. Mark Burman "Risks and Decisions for Conservation and environmental management", , Cambridge University Press.2003
3. Susan L |Cutter, "Environmental Risks and Hazards" Prentice Hall of India, New Delhi, 1999
4. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.
5. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., Global Environmental Risks, V.N.University Press, New York, 2003.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	1					3					2	
CO2	3	2	1	1		1	1						2	
CO3	3	2	2	2		2	2					3	2	
CO4	3	2	2										2	
CO5	3	2	1		3								2	
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE -1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE16	Remote Sensing and GIS Applications In Environmental Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in remote sensing and GIS				

Course Objectives

The course is intended to

1. Educate the students on principles of Remote Sensing
2. Learn the different remote sensing technique
3. Impart knowledge on Satellite Remote Sensing
4. Gain knowledge on image processing and geographical information system
5. Become knowledgeable on Remote Sensing and GIS Applications

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Execute the principles of remote sensing	Apply
CO2	Identify a suitable remote sensing technology	Understand
CO3	Explain the concepts of satellite remote sensing	Understand
CO4	Apply suitable image processing and geographical information system	Evaluate
CO5	Interpret the remote sensing and GIS applications	Apply

Course Contents:

Unit- I Remote Sensing Elements **9**

Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features, Energy recording technology

Unit- II Remote Sensing Technology **9**

Classification of Remote Sensing Systems, , Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR

Unit - III Satellite Remote Sensing **9**

Satellites and their sensors, satellite orbits, Indian space programme - Research and development - ISRO satellites, LANDSAT, ERS, SPOT, TERRA and NOOA satellite series, Characteristics of Remote Sensing data ,Satellite data Products

Unit- IV Image Processing and Geographical Information System **9**

Photogrammetry – Visual image interpretation, Digital image processing – Image rectification, enhancement, transformation, Classification, Data merging, GIS Concepts – Spatial and non spatial data, Vector and raster data structures, Data analysis, Database management – RS – GIS Integration, Image processing software, GIS software

Unit- V Remote Sensing and GIS Applications **9**

Monitoring and management of environment, Conservation of resources, Sustainable land use, Coastal zone management – Limitations

Total: 45 Periods

Reference Books:

1. Lillesand, T.M. and Kiefer, R.W, "Remote sensing and image interpretation", John Wiley and sons, New York, 2004.
2. Lintz, J.and Simonet," Remote sensing of Environment", Addison Wesley Publishing Company, New Jersey, 1998.
3. Pmapler and Applications of Imaging RADAR, Manual of Remote Sensing, Vol.2, ASPR, 2001.
4. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information systems" Oxford University Press, New York, 2001.
5. Golfried Konechy, Geoinformation: "Remote sensing, Photogrammetry and Geographical Information Systems", CRC press, 1st Edition, 2002.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	2										3	
CO2	3	2	1						2	3			3	
CO3	3	2	2	3	3				2	3		3	3	
CO4	3	2	2		3					3		3	3	
CO5	3	2	2	3		3	3					3	3	
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- II (7.5)	**IAE-II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

20PEEE17	Environmental Impact Assessment	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Knowledge in Environmental Engineering				

Course Objectives

The course is intended to

1. Gain knowledge on Legal and Regulatory aspects in India
2. Impart knowledge on Impact Identification and Prediction
3. Acquire knowledge on Social Impact Assessment and EIA Documentation
4. Prepare plan for environmental management
5. Utilize tools for environmental risk assessment and management

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Identify the types and limitations of Environmental Impact Assessment	Understand
CO2	Select a methodology for EIA by using software packages	Understand
CO3	Prepare documentation for EIA findings	Apply
CO4	Prepare EIA report and Environmental management plan	Apply
CO5	Apply tools for Environmental risk assessment and management	Apply

Course Contents:

Unit- I Introduction **9**

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**

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**

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**

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

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Unit- V Environmental Risk Assessment and Management **9**

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

Total: 45 Periods

Reference Books:

1. Rao. S.S., "Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 2009.
2. Richard Forsyth (Ed.), “Expert System Principles and Case Studies”, Chapman and Hall, 1996.
3. Shah V.L. “Computer Aided Design in Reinforced Concrete” Structural Publishers, 2014.
4. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Interscience, New Jersey. 2003
5. Sam Mannan, "Lees' Loss “Prevention in the Process Industries, Hazard Identification, Assessment and Control” 4th Edition, Butterworth Heineman, 2012.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2				3	3	3	2				2	
CO2	3	3				3	3	3	2			3	2	
CO3	3	3		3					2	2			2	
CO4	3	3		3				3	2	2			2	
CO5	3	2	2		3				2			3	2	
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
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	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE- I (7.5)	**IAE-II (7.5)**	**IAE-III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
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Evaluate				
Create				