DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI

OUR VISION:

Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering practice through excellence in teaching, research and consultancy to address sustainable infrastructure development needs at local, national and International levels.

OUR MISSION:

Department of Civil Engineering, Anna University shall contribute to technological and social development by

1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

M.E.ENVIRONMENTAL ENGINEERING (FULL-TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the programme ME Environmental Engineering will

PEO1	Gain knowledge and skills in environmental engineering which will enable them to have A career and professional accomplishment in the public or private sector organizations
PEO2	Become consultants on complex real life Environmental Engineering problems related to water supply, sewerage, sewage treatment, solid waste management, air pollution control, environmental impact assessment, industrial pollution control.
PEO3	Become entrepreneurs and develop processes and technologies to meet desired environmental protection needs of society and formulate solutions that are technically sound, economically feasible, and socially acceptable.
PEO4	Perform investigation for solving environmental problems by conducting research using Modern equipment and software tools.
PEO5	Function in multi-disciplinary teams and advocate policies, systems, processes and Equipment for control and remediation of pollution.

PROGRAMME OUTCOMES

Graduates of the programme ME Environmental Engineering will be able to

PO	Programme Outcomes
1.	An ability to independently carry out research/investigation and development work to solve practical problems
2.	An ability to write and present a substantial technical report/document
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
4.	Critically analyze complex Environmental Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.
5.	Conceptualize and solve Environmental Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio cultural factors
6.	Develop ability to engage in independent and life-long learning to improve competence by critical examination of the outcomes of one's actions in addressing Environmental issues and learning from corrective and preventive measures

Attested

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PEO/PO Mapping:

PROGRAMMEE DUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	3	2	3	3	3	3
II	3	3	2	3	3	2
III	3	3	2	3	3	3
IV	3	2	2	3	3	2
V	2	2	2	3	3	3

• 1-low, 2-medium, 3-high

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Environmental Statistics	3	2	2	2	2	2
		Environmental Chemistry	2	2	2	2	2	2
		Environmental Microbiology	3	2	2	2	2	2
		Design of Physico- Chemical Treatment Systems for water and wastewater	3	2	3	3	2	2
		Transport of water and Wastewater	3	2	2	2	2	2
		Research Methodology and IPR						
		Environmental Chemistry Laboratory	2	1	2	1	2	2
		Environmental Microbiology Laboratory	2	2	2	3	3	3
	SEMESTER II	Design of Biological Treatment Systems	2	1	3	3	3	2
		Air and Noise Pollution Control	2	2	2	2	2.	2
		Industrial Wastewater Pollution - Prevention and Control	3	2	3	2	3	2
		Professional Elective I						
		Professional Elective II						
		Environmental and Processes Monitoring Laboratory	2	2	2	3	3	3
		Seminar	3	3	3	3	2	3
YEAR II	SEMESTER III	Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Project Work – I	3	3	2	3	3	3
		Practical Training (Min 4 weeks)	3	2	2	3	2	2
	SEMESTERIV	Project Work – II	3	2	3	3	3	3

• 1-low, 2-medium, 3-high

MAPPING FOR PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Air Quality Modeling	1	1	2	1	2	2
2.	Advanced Oxidation Process	3	2	3	2	2	2
3.	Environmental and Sustainability	3	2	3	2	2	3
4.	Aquatic Ecosystem and Conservation	3	2	3	3	2	2
5.	Environmental Reaction Engineering	2	1	2	3	2	3
6.	Natural Systems for Wastewater Treatment	2	2	2	2	2	2
7.	Soft Computing in Environmental Engineering	3	2	3	3	3	3
8.	Design of Environmental Engineering Structures	3	2	2	3	3	3
9.	Marine Pollution and Control	2	3	3	3	3	3
10.	Water Quality Modelling	2	3	3	3	3	3
11.	Environmental System Analysis	3	2	2	2	3	3
12.	Environmental Monitoring Instruments	1	1	2	2	1	2
13.	Membrane Separation for Water and Wastewater Treatment	2	1	3	3	2	2
14.	Emerging Contaminants	3	2	3	2	2	2
15.	Project Formulation and Implementation	3	2	3	2	2	2
16.	Environmental Nanotechnology	3	2	2	2	2	2
17.	Solid and Hazardous Waste Management	3	1	3	3	2	2
18.	Environmental Management Systems and Auditing	3	1	3	3	2	2
19.	Operation and Maintenance of Water and Wastewater Treatment Systems	2	2	2	2	2	2
20.	Climate Change Modelling, Mitigation And Adaptation	3	3	2	2	3	2
21.	Environmental Impact and Risk Assessment	1	1	2	1	2	2

• 1-low, 2-medium, 3-high

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. ENVIRONMENTAL ENGINEERING (FULL-TIME)
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EN3151	Environmental Statistics	FC	4	0	0	4	4
2.	EN3101	Environmental Chemistry	PCC	3	0	4	7	5
3.	EN3102	Environmental Microbiology	PCC	3	0	4	7	5
4.	EN3103	Design of Physico- Chemical Treatment systems for water and wastewater	PCC	3	0	0	3	3
5.	EN3104	Transport of Water and Wastewater	PCC	3	0	0	3	3
6.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
			TOTAL	**18**	**1**	**8**	**27**	**23**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EN3201	Design of Biological Treatment Systems	PCC	4	0	0	4	4
2.	EN3251	Air and Noise Pollution Control	PCC	3	0	0	3	3
3.	EN3252	Industrial Wastewater Pollution- Prevention and Control	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
PRACTICAL								
6.	EN3211	Environmental and Processes Monitoring Laboratory	PCC	0	0	6	6	3
7.	EN3212	Seminar	EEC	0	0	2	2	1
			TOTAL	**16**	**0**	**8**	**24**	**20**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
PRACTICAL								
4.	EN3311	Project Work I	EEC	0	0	12	12	6
5.	EN3312	Practical Training (4 weeks)	EEC	0	0	0	0	2
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	EN3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	0	**0**	**24**	**24**	**12**

TOTAL CREDITS: 72

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EN3151	Environmental Statistics	4	0	0	4	I
					TOTAL CREDITS	3	

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EN3101	Environmental Chemistry	3	0	4	5	I
2.	EN3102	Environmental Microbiology	3	0	4	5	I
3.	EN3103	Design of Physico-Chemical Treatment Systems for Water and Wastewater	3	0	0	3	I
4.	EN3104	Transport of Water and Wastewater	3	0	0	3	I
5.	EN3201	Design of Biological Treatment Systems	4	0	0	4	II
6.	EN3251	Air and Noise Pollution Control	3	0	0	3	II
7.	EN3252	Industrial Wastewater Pollution- Prevention and Control	3	0	0	3	II
8.	EN3211	Environmental and Processes Monitoring Laboratory	0	0	6	3	II
					TOTAL CREDITS	**29**	

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	EN3001	Air Quality Modeling	3	0	0	3
2.	EN3002	Advanced Oxidation Process	3	0	0	3
3.	EN3003	Environmental and Sustainability Planning	3	0	0	3
4.	EN3004	Aquatic Ecosystem and Conservation	3	0	0	3
5.	EN3005	Environmental Reaction Engineering	3	0	0	3
6.	EN3006	Natural Systems for Wastewater Treatment	3	0	0	3
7.	EN3007	Soft Computing in Environmental Engineering	3	0	0	3
8.	EN3008	Design of Environmental Engineering Structures	3	0	0	3
9.	EN3051	Marine Pollution and Control	3	0	0	3
10.	EN3009	Water Quality Modelling	3	0	0	3
11.	EN3010	Environmental System Analysis	3	0	0	3
12.	EN3011	Environmental Monitoring Instruments	3	0	0	3
13.	EN3052	Membrane Separation for Water and Wastewater Treatment	3	0	0	3
14.	EN3012	Emerging Contaminants	3	0	0	3
15.	EN3013	Project Formulation and Implementation	3	0	0	3
16.	EN3014	Environmental Nanotechnology	3	0	0	3
17.	EM3252	Solid and Hazardous Waste Management	3	0	0	3
18.	EM3051	Environmental Management Systems and Auditing	3	0	0	3
19.	EM3052	Operation and Maintenance of Water and Wastewater Treatment Systems	3	0	0	3
20.	EM3053	Climate Change Modelling, Mitigation And Adaptation	3	0	0	3
21.	EM3251	Environmental Impact and Risk Assessment	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM3151	Research Methodology and IPR	2	1	0	3	I
TOTAL CREDITS						3	

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EN3212	Seminar	0	0	2	1	II
2.	EN3312	Practical Training (4 weeks)	0	0	0	2	III
3.	EN3311	Project Work I	0	0	12	6	III
4.	EN3411	Project Work II	0	0	24	12	IV
TOTAL CREDITS						**21**	

Summary

NAME OF THE PROGRAMME: M.E ENVIRONMENTAL ENGINEERING						
S. No	**Subject Area**	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	**FC**	4	--			**4**
2.	**PCC**	16	13			**29**
3.	**PEC**	---	6	9		**15**
4.	**RMC**	3				**3**
5.	**EEC**	---	1	8	12	**21**
	Total	**23**	**20**	**17**	**12**	**72**

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EN3151 ENVIRONMENTAL STATISTICS L T P C
4 0 0 4

UNIT I ENVIRONMENTAL DATA 12

Environmental data; types and objectives **-** Air, Water, Noise, Climate and Meteorological Data- generation -measurement scales; interpreting environmental standards and data- Environmental Problems and Statistics

UNIT II ENVIRONMENTAL STATISTICS 12

Statistical descriptors of environmental data – numerical and graphical; uncertainty – accuracy, precision and bias estimation of environmental data; variability and errors in environmental data. concept of random variable and its relevance.

Probability concepts; probability distribution functions and their applications-discrete and continuous distributions. Probability distribution applications-.

UNIT III ENVIRONMENTAL DATA SAMPLING AND ANALYSIS 12

Need and purpose of sampling; types of sampling designs-probability and non-probability sampling designs for environmental monitoring- Sampling theory, sampling distributions; environmental parameter estimation-point and interval estimates; confidence interval estimation; sample size determination Hypothesis testing-parametric and non-parametric tests: assessment of violation of environmental standards, comparing environmental parameters

UNIT IV ENVIRONMENTAL DATA ANALYTICAL TOOLS 12

Correlation analyses: graphical analysis, covariance, correlation coefficient, distribution of correlation coefficient and its statistical significance. Empirical model Building-Regression analysis: assumptions and definitions, principle of least squares, regression parameters their distribution.

Analysis of Variance(ANOVA); Mid-term Exercises- Multivariate exploratory technique Ordination, principle component analysis- Cluster analysis- Diversity measure- Machine leaning- Monte-Carlo method and risk assessment

UNIT V APPLICATIONS AND CASE STUDIES 12

Case studies: Climate change and volume-discharge curve Applications: Stage-discharge curve and volume-discharge curves, water quality parameters and agriculture. Analysis of trend in the environmental data Introduction to time-series analysis; characteristics of hydrological, water and air quality time series; Trend and seasonality; detecting and estimating trends-applications to hydrological, meteorological, water and air quality data.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

By the end of this course, students will be able to:

CO1 Statistically analyse and present the environmental data

CO2 demonstrate the applications of statistical techniques to problems drawn from industry, management and other engineering fields

CO3 Explain major statistical analysis and modeling techniques for scientific understanding of environmental problems

CO4 Select appropriate statistical analysis methods depending on particular environmental problem and type of data

CO5 Apply major statistical analysis and modeling techniques to particular dataset, and interpret the results from such applications.

REFERENCES:

1. Environmental and Ecological Statistics with R, 2010, S. S. Quin, CRC Press
2. Environmental Statistics: Methods and Applications, 2003, Vic Barnett, wiley
3. Statistics for Environmental Science and Management, 2008, Bryan F.J. Manly, CRC Press
4. Statistics for Environmental Engineers, Linfield C. Brown, Paul Mac Berthouex, 2002, CRC Press
5. Statistical Tools for Environmental Quality Measurement, 2003, Douglas E. Splitstone, Michael E. Ginevan, Chapman & Hall

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	2	2	3	3
CO3	3	2	2	2	2	2
CO4	2	3	2	2	2	3
CO5	3	2	3	3	2	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3101 ENVIRONMENTAL CHEMISTRY L T P C
3 0 4 5

UNIT I FUNDAMENTALS 9

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp) ,heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order and pseudo order examples- 12 Principles of green chemistry

UNIT II AQUATIC CHEMISTRY 11

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of natural and 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 7

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO_2 mitigation and net zero emission – acid rain- origin and composition of particulates. black carbon, air quality parameters 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 electrokinetic remediation.

UNIT V EMERGING TRENDS 9

Chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals- Pesticides, Dioxins & Furan, PCBs , PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites ,environmental applications, Green Hydrogen generation.

List of experiments 60

1. Calibration of pipette and estimation of SD and CV
2. Calibration and Measurement of pH, EC and turbidity of water sample
3. Estimation of Chloride in Water sample by volumetric titration
4. Determination of fluoride in water by spectrophotometric/Ion selective method
5. Determination of sulphate of water sample by spectrophotometric method
6. Determination of colour in water and wastewater samples
7. Determination of phosphate by molybdenum blue method
8. Determination of Total Solids, Total suspended solids, Total dissolved solids by gravimetry
9. Determination of COD in wastewater sample
10. Sampling and determination of BOD in the wastewater sample
11. Sampling and determination of ammonia/TKN in wastewater sample
12. Sampling and characterization of soil for Na and K
13. Sampling and characterization of solid waste for Moisture, organic and inorganic matters

TOTAL: 105 PERIODS

COURSE OUTCOMES:

CO1: Students will gain competency in solving environmental issues of chemicals based pollution
CO2: Ability to determine chemicals mobility in aquatic systems
CO3: Ability to identify contaminating chemicals in air and their fate
CO4: Understand the type of soil contaminants and provide remediation
CO5: Identify emerging environmental contaminants and nano tech applications including green hydrogen

REFERENCES:

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
3. Manahan, S.E., "Environmental Chemistry", Tenth Edition, CRC press, 2017.
4. Jonathan D. Raff, Ronald A. Hites,"Elements of Environmental Chemistry", Wiley, 3rd Edition,2020.
5. APHA, "Standard Methods for the Examination of Water and Wastewater", 23 rd Ed. Washington, 2017.
6. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist, H. – VCH, Germany, 3rd Edition, 1999.
7. "Methods of air sampling & analysis", James P.Lodge Jr(Editor) 3rd Edition, Routledge; 2020

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	3	2
CO2	2	2	2	2	1	2
CO3	3	2	2	2	3	2
CO4	3	2	2	2	1	2
CO5	2	2	2	2	1	2
Avg	**2**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3102 ENVIRONMENTAL MICROBIOLOGY L T P C
3 0 4 5

UNIT I FUNDAMENTALS OF MICROBIOLOGY 9

Classification of microorganisms – prokaryotic, eukaryotic, ultra-structure of cell – Gram positive, Gram negative, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, bacteriophages – lytic and lysogenic cycles, concentration and detection of virus, isolation, characterization of bacteria, preservation , DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

UNIT II MICROBIAL DIVERSITY AND NUTRIENTCYCLING 9

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, extreme environment, aerosols, bio safety in laboratory, Algae – occurrence in water supplies – types, problems and control, biogeochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganisms in nutrient cycle.

UNIT III METABOLISM OF MICROORGANISMS 9

Factors affecting growth of microorganisms – Nutrition, pH, temperature, oxygen, growth phases, Metabolism – carbohydrate – glycolysis, Kreb's cycle, hexose monophosphate pathway, protein metabolism, lipid metabolism, respiration – aerobic, anaerobic, fermentation, phosphorylation- types, enzymes – classification, mechanism of action.

UNIT IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS 9

Microbiology of biological treatment processes – aerobic and anaerobic, α-oxidation, β-oxidation, nitrification and denitrification, eutrophication, nutrients removal – BOD, nitrogen, phosphate. microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, *E. coli*, Streptococcus, Clostridium, Bioleaching

UNIT V TOXICOLOGY 9

Ecotoxicology – toxicants and toxicity, factors influencing toxicity. effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – bioaccumulation and biomagnification – causes, effects, bioassay, biomonitoring – techniques, considerations for designing biomonitoring studies, ethical aspects, issues - biomarkers in environmental monitoring.

LIST OF EXPERIMENTS 60

1. Preparation of culture media (Broth and Solid)
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)
4. Measurement of growth of microorganisms
5. Analysis of air borne microorganisms
6. Staining of bacteria (Gram Staining technique)
7. Effect of pH, temperature on microbial growth
8. Bacteriological analysis of wastewater (Coliforms, *E.coli,* Streptococcus) – MPN
9. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques
10. Effect of Heavy metals on microbial growth
11. Detection of anaerobic bacteria
12. Bioreactors (cultivation of microorganisms)

TOTAL: 105 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1: Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights

CO2: Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

CO3: Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes

CO4: Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.

CO5: Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

REFERENCES

1. Patrick K. Jjemba. “Environmental Microbiology: Principles and Applications”. Scientific Publishers, 2004, 978-1578083473.
2. Bhatia S.C., "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 20083 Gabriel Bitton, Wastewater Microbiology, 2nd Edition,
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press, 2000
4. Volodymyr Ivanov, Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2015, ISBN 9781498702126
5. Nduka Okafor, Environmental Microbiology of Aquatic and Waste systems. Springer Publishers, 2011, ISBN 978-94-007-1459-5
6. Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 2008
7. Mitchell R, Gu, J. “Environmental Microbiology” 2nd Edition, Wiley India, 2016., ISBN 9788126563203.

8. APHA, "Standard Methods for the Examination of Water and Wastewater", 23rd Ed. Washington, 2017.
9. 6. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist, H. –VCH, Germany, 3rd Edition, 1999.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	2	2	3	3
CO3	3	2	2	2	2	2
CO4	2	3	2	2	2	3
CO5	3	2	3	3	2	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3103 DESIGN OF PHYSICO- CHEMICAL TREATMENT SYSTEMS FOR WATER AND WASTEWATER **L T P C 3 0 0 3**

UNIT I INTRODUCTION **5**

Pollutants in Water and Wastewater – Characteristics, Standards for performance – Significance of Physico-chemical treatment – Selection criteria – Types of reactor – Batch and continuous type - Kinetics – Hydraulics of reactor - Water requirement for domestic and industrial purposes - Overview of Physical chemical treatment in Water and Wastewater Treatment Plants.

UNIT II TREATMENT PRINCIPLES **10**

Physical Treatment units - Screening – Flow equalization – Grit chamber – Skimming tank – Flotation –. Mixing – Sedimentation – Filtration – Evaporation – Aeration and Gas Transfer – Mass transfer coefficient - Adsorption – isotherms – Membrane separation - Air stripping – Crystallization – Reverse Osmosis – Electrodialysis - Chemical Treatment units - Neutralization - Coagulation and Flocculation – Precipitation – Ion exchange- Advanced oxidation – Disinfection - Recent Trends.

UNIT III DESIGN OF MUNICIPAL WATER TREATMENT PLANTS **10**

Design of Municipal Water Treatment Units - Selection of Treatment - Aeration – Chemical feeding – Coagulation and flocculation - Clarifier – Rapid and slow sand filters – Pressure filter, dual media and multimedia filter – Disinfection - Hydraulic profile – Flow charts - Plant sizing and layout – Recent trends.

UNIT IV DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS **10**

Design of Industrial Water Treatment Units - Selection of Treatment – Design of Softeners - Demineralisers – RO Plants - RO reject Management – Flow charts - Plant sizing and layout – Recent Trends.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS **10**

Design of Municipal Wastewater Treatment Units - Screening - Grit chamber – Settling tanks – Sludge dewatering - Sludge thickening – Sludge drying beds - Design of Industrial Wastewater Treatment Units – Equalization – Neutralization – Mixing – Flotation – Oil skimmer - Membrane filtration - Electrodialysis – Adsorption - Advanced Oxidation – Evaporator - Hydraulic profile – Residual management - Flow charts – Plant sizing and layout – Recent Trends.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

- On Completion of the course, the student is expected to be able to

CO1 Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design

CO2 Describe the principles of physico-chemical treatment systems and choose the relevant treatment systems for effective water and wastewater treatment

CO3 Design the treatment scheme for municipal and industrial water, wastewater to meet the specific needs on residue management

CO4 Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable

CO5 Conduct research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems in collaboration with municipalities, corporation, pollution control boards and industries

REFERENCES:

1. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, "Wastewater engineering, treatment and reuse", Fourth Edition, McGraw-Hill, 2017.
2. Qasim S.R., Guang Zhu., "Wastewater Treatment and Reuse", Volume 1& 2 2018.
3. Rumana Riffat, "Fundamentals of Wastewater Engineering", IWA Publishing, 2013.
4. Lawrence K. Wang, Yung-Tse Hung, Nazih K. Shammas, "Advanced Physicochemical Treatment Technologies", Volume 5, Humana Totowa, NJ, 2007.
1. Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw Hill, New York, 1999.
2. Peavy H. S., Rowe, D. R. Tchobanoglous G, "Environmental Engineering", McGraw Hills, New York, 2013.
3. Sincero A. P. and Sincero G. A., "Physical-Chemical Treatment of Water and Wastewater", IWA Publishing, 2002.
4. Mackenzie L.Davis, David A. Cornwell, "Introduction to Environmental Engineering", McGraw Hill, 1998.
5. Sincero A. P. and Sincero G. A., "Environmental Engineering: A Design Approach", Prentice hall, 1995.
6. CPHEEO manual – "Manual for sewerage and sewage treatment systems" – Part A,B,C, Ministry of Urban development, New Delhi,2013.
7. CPHEEO manual – "Manual for water supply and treatment" – Ministry of Urban development, New Delhi, 1999.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	2	2	3	3	3	2
CO4	3	2	3	3	3	3
CO5	3	3	3	3	2	3
Avg	**3**	**2**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3104 TRANSPORT OF WATER AND WASTEWATER L T P C
3 0 0 3

UNIT I GENERAL HYDRAULICS 9

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor head losses, carrying capacity– flow measurement. need for transport of water and wastewater and types

UNIT II WATER TRANSMISSION MAINS 9

Planning of water system – design of storage reservoirs - water transmission main design- compound gravity and pumping main; selection of pumps and characteristics curve - economics; specials, jointing, laying and maintenance, water hammer analysis; Surge Analysis-importance, protection, software analysis

UNIT III WATER DISTRIBUTION 9

Service reservoirs-types and design. water distribution pipe networks design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection. plumbing for water supply in high rise buildings. use of computer software in water transmission, water distribution design – EPANET 2.0, LOOP version 4.0, BRANCH,

UNIT IV WASTEWATER COLLECTION AND CONVEYANCE 9

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. plumbing for drains in high rise buildings-Combined Sewers

UNIT V STORM WATER DRAINAGE 9

Necessity- combined and separate system; estimation of storm water runoff - formulation of rainfall intensity duration and frequency relationships- rational methods. CPHEEO model Design; Use of computer softwares in sewer design–sewer. SewerCAD, SewerGEMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On Completion of the Course the student will be able to

CO1 Understand general hydraulics and need for proper collection and conveyance of water and wastewater
CO2 Design economic diameters of gravity and pumping mains and storage reservoirs
CO3 Design and analysis of water distribution networks and apply computer softwares
CO4 Design sewer networks for various flow conditions
CO5 Design storm water drain and apply computer softwares for design of sewers.

REFERENCES:

1. Pramod R. Bhave, Rajesh Gupta. “Analysis of Water Distribution Networks”, Alpha Science International, 2006
2. Bajwa, G.S. "Practical Handbook on Public Health Engineering", Deep Publishers, Shimla, 2003
3. “Manual on water supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
4. “Manual on Sewerage and Sewage Treatment Part-A Engineering”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	2	2	3	3
CO3	3	2	2	2	2	2
CO4	2	3	2	2	2	3
CO5	3	2	3	3	2	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

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EN3201 DESIGN OF BIOLOGICAL TREATMENT SYSTEMS L T P C
4 0 0 4

UNITI REACTION KINETICS AND BIO REACTORS 12

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 organic removal- enzyme kinetics biodegradability assessment - selection of process-reactors- biokinetics - batch reactor - continuous flow stirred tank reactor-plug flow reactor - flowcharts, layout, PID, hydraulic profile

UNITII CONVENTIONAL AEROBICTREATMENT PROCESSES 12

Design of sewage treatment plant units –activated sludge process and variations-trickling filters- bio-tower-RBC- fluidized bed reactors, aerated lagoons, waste stabilization ponds– natural treatment systems, constructed wetland - disposal options – reclamation and reuse – recent trends.

UNIT III ADVANCED AEROBICTREATMENT PROCESSES OF WASTEWATER 12

Sequencing batch reactors- moving bed biofilm reactors- membrane bioreactor- reclamation and reuse of wastewater-design of tertiary treatment units-application of membrane separation technologies in reuse of sewage -case studies

UNIT IV ANAEROBICTREATMENT OF WASTEWATER 12

Attached and suspended growth process -design of units–UASB – post treatment systems for UASB reactor-anaerobic filters – expanded bed and fluidized bed anaerobic systems -septic tank and soil disposal system - anaerobic baffled reactor–anaerobic sludge digestion process -types of anaerobic sludge digesters – design of low rate and high rate anaerobic digestors- recent trends.

UNIT V NUTRIENT REMOVAL SYSTEMS 12

Nutrients in wastewater –significance - nitrification and denitrification-nitrogen removal systems – anaerobic ammonium oxidation (ANAMMOX) - Reactors for ANAMMOX process development - Polyphosphate-accumulating organisms (PAOs)–anaerobic and aerobic metabolism of phosphorus in phosphate accumulating bacteria -enhanced biological phosphorus removal (EBPR) –recent trends – case studies

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand the microbial process and its kinetics
CO2 Design and size the different components of conventional aerobic treatment systems.
CO3 Design and size the different components of advanced aerobic treatment systems.
CO4 Understand in detail about the anaerobic treatment of wastewater which includes the design of attached and suspended growth processes.
CO5 Design the different elements of nutrient removal systems

REFERENCES:

1. ArceivalaS.J.,and Asolekar S.R" Wastewater Treatment for Pollution Control and reuse" McGraw Hill, third Edition, NewDelhi, 2007.
2. Manual for “Sewerage and Sewage Treatment Systems”, PART- A, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
3. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
4. Qasim, S. R. and Guang Zhu "Wastewater Treatment and Reuse. Theory and Design Examples", CRC Press, New York, 2018.
5. F.R. Spellman, "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York2020.
6. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press, New York 2011.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	3	2
CO2	2	1	3	3	3	2
CO3	2	1	3	3	3	2
CO4	2	1	3	3	3	2
CO5	2	1	3	3	3	2
Avg	2	1	3	3	3	2

• 1-low, 2-medium, 3-high

EN3251 AIR AND NOISE POLLUTION CONTROL L T P C
3 0 0 3

UNIT I INTRODUCTION 9

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 bodies – Long- term effects– Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories- Indoor Air Pollution

UNIT II AIR POLLUTION MONITORING AND MODELLING 9

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 – Modelling Techniques – Air Pollution Climatology.

UNIT III CONTROL OF PARTICULATE POLLUTANTS 9

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 – Operational Considerations - Costing of APC equipment –. Recent Advances

UNIT IV CONTROL OF GASEOUS POLLUTANTS 9

Factors affecting Selection of Control Equipment -Working principle, Design and performance equations of Absorption, Adsorption, Condensation, Incineration, Bio-scrubbers, Bio-filters –Control Technologies-SO_2,NO_x CO, H_2S; VOC, Process control and Monitoring - Operational Considerations - Costing of APC Equipment –Emerging Trends,

UNIT V NOISE POLLUTION 9

Noise Pollution: Sources and Effects of Noise Pollution – Measurement – Equivalent Noise Level- Ambient and Source Noise Standards -Occupational Noise- Sampling of ambient and industrial Noise-Statistical Analysis of Noise Control and Preventive measures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the student is expected to be able to understand:

CO1 Various types and sources of Air Pollution and its effects
CO2 Methods of source and ambient monitoring and dispersion of pollutants and their modeling
CO3 The principles and design of control of particulate pollutants
CO4 The principles and design of control of Gaseous pollutant
CO5 Sources, effects and control of vehicular, indoor air and noise pollution

REFERENCES:

1. Noel de Nevers, "Air Pollution Control Engg", Mc Graw Hill, New York, 2016.
2. Daniel Vallero “Fundamentals of Air Pollution”, Fourth Edition, 2008.
3. Arthur C.Stern, “Air Pollution (Vol.I – Vol.VIII)”, Academic Press, 2006.
4. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004.

5. David H.F. Liu, Bela G. Liptak, “Air Pollution”, Lweis Publishers, 2000.
6. Wayne T.Davis, “Air Pollution Engineering Manual”, John Wiley & Sons, Inc., 2000.
7. P.K.Behera ,S.K.Sahu,Environmental Monitoring and Analysis,Dominant publishers and Distributors, New Delhi, 2009
8. Central Pollution Control Board, Guidelines for real time sampling and analysis , 2013.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	3
CO2	2	2	2	2	3	2
CO3	3	2	2	2	2	2
CO4	2	3	3	3	2	3
CO5	2	2	3	2	3	2
Avg	**2**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3252 INDUSTRIAL WASTEWATER POLLUTION - PREVENTION AND CONTROL **L T P C 3 0 0 3**

UNIT I INTRODUCTION **8**

Industrial scenario in India – Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater - Characteristics of Industrial effluents – 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 and Bioassay tests – Major issues on water quality management.

UNIT II INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION **8**

Sources of Pollution – Effects of industrial effluents on sewers and Natural water Bodies – Impact Assessment – Environmental Audit - Prevention vs Control of Industrial Pollution - Source Reduction Techniques - Evaluation of Pollution Prevention Options - Waste Minimization – Cost benefit analysis – Payback period – Implementing Pollution prevention programmes in industries.

UNIT III INDUSTRIAL WASTEWATER TREATMENT **10**

Equalization and Neutralization – Oil Separation - Flotation - Precipitation - Aerobic and Anaerobic Biological Treatment - Treatability studies - Air Stripping – Refractory organics removal by Absorption - Nitrification and Denitrification - Phosphorous removal - Heavy metal removal - Sequencing Batch Reactors - High Rate Reactors - Chemical Oxidation – Advanced Oxidation - Evaporation - Ion Exchange - Membrane Technologies - Advanced Treatment Methods.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT **9**

Individual and Common Effluent Treatment Plants - Joint treatment of industrial and domestic wastewaters - Integrated Wastewater Management for Zero Effluent Discharge Systems –Disposal of Effluent on Land – Wastewater irrigation system - Recycle and reuse of wastewater - Residual Management - Thickening, Dewatering and Disposal of Sludge

UNIT V CASE STUDIES **10**

Industrial Manufacturing process description, Wastewater Characteristics, Source reduction, Treatment and disposal of highly polluting industries viz., Textile - Pulp and Paper – Tannery - Sugar - Distillery - Dairy - Petroleum refinery - Electro plating.

TOTAL: 45 PERIODS

COURSE OUTCOME:

- On Completion of the course, the student is expected to be able to

CO1 Explain the source and types of industrial wastewater and their environmental impacts and choose the regulatory laws pertaining to environmental protection

CO2 Identify industrial wastewater pollution and implement pollution prevention, waste minimization in industries

CO3 Develop various technologies for removal pollutants from industrial wastewater and design wastewater treatment systems for industries

CO4 Audit and analyze environmental performance of industries to internal, external client, regulatory bodies and design water reuse management techniques

CO5 Conduct research to develop effective management systems for industrial wastewater that are technically sound, economically feasible and socially acceptable

REFERENCES:

1. Athar Hussain, Sirajuddin Ahmed, “Advanced Treatment Techniques for Industrial Wastewater”, IGI Global Publisher, 2018.
2. Shyam. R. Asolekar, Soli. J. Arceivala, “Waste water Treatment for pollution control and reuse”,Tata Mcgraw Hill, 2007.
3. Frank Woodard, “Industrial Waste Treatment Handbook”, Butterworth Heinemann, New Delhi, 2001.

   Paul L. Bishop, “Pollution Prevention: Fundamentals and Practice', Mc-Graw Hill International, Boston,2000.
5. "Industrial wastewater management, treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 2008.
6. Lawrance K. Wang, Yung Tse Hung, Howard H.Lo and Constantine Yapijakis “hand book of Industrial and Hazardous waste Treatment”, Second Edition,2004.
7. Qasim S.R., Guang Zhu., “Wastewater Treatment and Reuse”, Volume 1& 2 2018.
8. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
9. Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier,2007.
10. Wesley Eckenfelder W., “Industrial Water Pollution Control”, Second Edition, Mc Graw Hill, 2000.
11. Nemerow, N.I, Butterworth-Heinemann, “Theories of practice of Industrial Waste Treatment”, 2006.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	3	2
CO3	3	2	3	3	2	3
CO4	3	3	3	2	3	2
CO5	3	3	3	3	3	3
Avg	3	2	3	3	3	2

• 1-low, 2-medium, 3-high

EN3211 ENVIRONMENTAL AND PROCESSES MONITORING LABORATORY L T P C
0 0 6 3

EXCERCISES

1. Coagulation and Flocculation
2. Batch studies on settling
3. Studies on Filtration- Characteristics of Filter media
4. Water softening
5. Adsorption studies/Kinetics
6. Langelier Saturation Index and Silt Density Index- For Membrane Filtration
7. Kinetics of suspended growth process (activated sludge process)-and Sludge volume Index
8. Sludge Filterability Test
9. Anaerobic Reactor systems / kinetics (Demonstration)
10. Advanced Oxidation Processes – (Photo catalysis)
11. Disinfection for Drinking water (Chlorination)
12. Ambient Air Sampling-Determination of PM10, PM2.5, SO_2 and NO_2
13. Noise Monitoring-Determination of Equivalent Noise Level

TOTAL: 90 PERIODS

COURSE OUTCOME:

After the completion of the course the students will be able

CO1 Able to determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics

CO2 Able to determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants

CO3 Able to Determine Equivalent Noise Level by noise monitoring

REFERENCES:

1. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
2. Lee, C.C. and Shundar Lin. "Handbook of Environmental Engineering Calculations", Mc Graw Hill, New York, 1999.
3. AEESP Environmental Processes Laboratory Manual, Association of Environmental Engineering and Science Professors Foundation, Washington, 2002.
4. Aery N C., “Manual of Environmental Analysis”, Ane Books Pvt. Ltd. New Delhi, 2014
5. CPCB, Guidelines for the Measurement of Ambient Air Pollutants, Volume I, Central Pollution Control Board, Ministry of Environment and Forests, Government of India, 2001

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	2	2	2	3	3	3
CO3	2	2	2	3	3	3
Avg	**2**	**2**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3212 **SEMINAR** **L T P C**
0 0 2 1

SYLLABUS CONTENT

The students have to select any advanced topic of their choice related to Environmental Engineering, generally a topic, which is not a part of syllabus of a regular course. The students will have work for two hours per week. Students shall submit a brief report on their seminar topic and present the seminar. It will be an open seminar. The valuation will be based on the content of the report, technical presentation and the interaction during the seminar. A three-member committee constituted by HoD will evaluate the report and presentation.

TOTAL: 30 PERIODS

COURSE OUTCOME:

CO1 Identify various innovative and latest advancements in the Environmental field through research studies.

CO2 Improve their communication skills and Understand the art of writing research work through analysis of a specific topic in the related field.

CO3 Learn to make good presentation and explain a concept.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	3	2	2	1	1
CO3	2	3	2	2	1	1
Avg	**2**	**3**	**2**	**2**	**1**	**1**

• 1-low, 2-medium, 3-high

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EN3311 **PRACTICAL TRAINING (4 WEEKS)** **L T P C**
0 0 0 2

Syllabus Content:

- Students shall undertake training either individually or group (not exceeding four members in a group) in reputed Companies identified by Centre for Environmental Studies, dealing with Water treatment, sewage treatment, effluent treatment, Solid waste Processing Facility, Industrial Waste management cells, Environmental consultancies, Air pollution control, Environmental Impact Assessment and any other environmental management related works during the summer vacation of II semester for a specified period of four weeks.
- Students allowed to get field exposure and effectively interact with Environmental engineers
- At the end of training, a detailed report on the work done should be submitted to the course coordinator
- Students will be evaluated through a viva-voce examination by a team of internal staff members constituted by HoD.

COURSE OUTCOME:

CO1 Understand the various organizations and to have an exposure on projects carried out and understand the real field problem and compare the theoretical knowledge with field
CO2 Develop knowledge in analysing and uunderstand the professional ethics
CO3 Solve Environmental related problems in the field either individually or in team

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	3	2	2	2	2
Avg	**2**	**2**	**2**	**2**	**2**	2

• 1-low, 2-medium, 3-high

EN3312 **PROJECT WORK I** **L T P C**
0 0 12 6

SYLLABUS:

The student individually works on a specific topic supervised 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 filed related studies. The progress if the work will be evaluated internally through reviews by a committee constituted by HoD. 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, methodology for carrying out the work and results of preliminary works. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner, Supervisor and an Internal Examiner.

TOTAL: 180 PERIODS

COURSE OUTCOME:

students will be able to

CO1 Identify Environmental engineering problems and critically evaluate literature in a chosen area of research and establish the scope of work
CO2 Develop study methodology, and identify appropriate techniques to analyze complex Environmental engineering problems
CO3 Apply engineering and management principles through efficient handling of the project and demonstrate a sound technical knowledge of their selected project topic

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	2	2	3	3	3	3
CO3	2	2	3	3	3	3
Avg	2	2	3	3	3	3

• 1-low, 2-medium, 3-high

EN3411 PROJECT WORK II L T P C
0 0 24 12

SYLLABUS:
The student may continue the Project work I on the selected topic as per the formulated methodology or they can do different project in an industry. 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 based on the report and the viva-voce examination by a panel of examiners including one external examiner, Supervisor and an Internal Examiner.

TOTAL: 360 PERIODS

COURSE OUTCOME:
students will be able to

CO1 Identify Environmental engineering problems and critically evaluate literature in a chosen area of research and establish the scope of work

CO2 Develop study methodology, and identify appropriate techniques to analyze complex Environmental engineering problems

CO3 Apply engineering and management principles through efficient handling of the project and demonstrate a sound technical knowledge of their selected project topic

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	2	2	3	3	3	3
CO3	2	2	3	3	3	3
Avg	2	2	3	3	3	3

• 1-low, 2-medium, 3-high

PROFESSIONAL ELECTIVE COURSES

EN3001 AIR QUALITY MODELLING L T P C
3 0 0 3

UNIT I MODELLING AND MODELS 9

Overview of different types of models-deterministic and stochastic approach- steps in model development- numerical and simulations models- calibration and validation of models- limitations-transport phenomena- mass balance analysis-model development and decision making. Types of air quality models-classification

UNIT II METEOROLOGY AND DISPERSION 9

Chemistry of air Pollutants - atmospheric reactions, sinks for air pollution –transport of air pollutants - meteorological factors for dispersal of air pollutants – meteorological modelling-developing wind rose and pollutant rose diagrams-vertical structure of temperature and stability, mixing height; tall

stacks-transport and diffusion of stack emissions –plume segments–flare stack–plume rise equations-Holland's and Brigg's models.

UNIT III EMISSION AND SOURCE DISPERSION MODELS 9

modeling for reactive and nonreactive pollutants, point source-single and multiple sources- area sources, line source models, fixed box models- diffusion models – Gaussian plume derivation-modifications of Gaussian plume equation- Gaussian puff model- emission models-emission factors-long term average-multiple cell model-accuracy and utilization-limitations-air quality mapping

UNIT IV RECEPTOR MODELS AND INDOOR AIR QUALITY MODELS 9

Receptor models- source apportionment studies- CMB model- PMF models; environmental wind tunnel models; indoor air pollutants –mass balance-single compartment-multiple compartments calculation of deposition velocity and Position of Particles-Aerosol-Odours and sick building syndrome-Integrated Models.

UNIT V SOFTWARE PACKAGE APPLICATIONS 9

Demonstration of Air Quality Model Softwares- ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSPLIT, INDEX

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- At the end of the course the student will be to

CO1 Concepts and types of models, model development, their applicability and limitations.
CO2 Understand the physicochemical transformation of air pollutants in the atmosphere along with the meteorological influence in dispersion of pollutants.
CO3 Identifies emission source and applies suitable modeling tools to estimate the impact of the pollutants.
CO4 Fetch knowledge on source inventories, model prediction efficiency and potential risk assessment.
CO5 Understand the application of models to predicts the air quality scenarios for different conditions and find suitable mitigation measures.

REFERENCES:

1. Noel de Nevers, "Air Pollution Control Engg"., Mc Graw Hill, New York, 2016.
2. Arthur C.Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004
4. John H. Seinfeld and Spyros N. Pandis Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition, , 2006,
5. Mark Z. Jacobson Fundamentals of Atmospheric Modeling, 2nd Edition, 2005,
6. Deaton and Wine Brake, "Dynamic Modeling of Environmental Systems", Wiley & Sons, 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	-
CO2	1	1	1	2	2	3
CO3	1	1	1	1	1	1
CO4	-	2	2	1	3	1
CO5	1	2	3	2	3	3
Avg	**1**	**1**	**2**	**1**	**2**	**2**

• 1-low, 2-medium, 3-high

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

EN3002 ADVANCED OXIDATION PROCESS L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Fundamentals of Advanced Oxidation Processes (AOPs) – Principle and Mechanism of Oxidation - Different AOPs for Wastewater Remediation - Hydroxyl radicals, properties, detection and reactions with organic compounds - UV/Hydrogen peroxide process - Ozone/hydrogen peroxide and ozone/UV processes - Photocatalysis - Fenton, Photo-Fenton and Fenton like process - Oxidation pathway during non-photochemical and photochemical oxidation processes for the treatment of water.

UNIT II HOMOGENOUS AOPs 8

Photochemical AOPs – Utilization different Photocatalysts in Photocatalysis - Ozonation, O_3 - Ultraviolet radiation, UV Ultraviolet radiation in the presence of Hydrogen Peroxide, UV/H_2O_2 - Oxidation in the presence of Iron(III) or Iron(II) salts and hydrogen peroxide, H_2O_2 (Fenton and photo-Fenton oxidation) – Electrochemical Oxidation.

UNIT III HETEROGENEOUS AOPs 10

Heterogeneous Photocatalysis - Sonolysis and Sono-photocatalysis - Synthesis and Characterization of Catalysts – Process and mechanism – Fenton Catalysis – Electro Catalysis – Applications of chemical kinetics – Solar/Artificial light photo reactors – system design – Nano photocatalysis effect of system composition and process – Physico chemical methods for characterization of Nano materials.

UNIT IV AOP ENHANCEMENT TECHNIQUES 9

Enhanced Fenton process – Hydroxyl radical based AOPs - Sulfate radical ion based AOPs – Electrical discharge plasma for water treatment - Zerovalent iron nanoparticles and ferrates in advanced oxidation processes - ´Y-rays, electron beams, Quantum yield improvement by Additional Oxidants - Hydrogen peroxide per sulphate – Catalyst modification – Case studies and application of semiconductor photolysis – Hybrid AOPs.

UNIT V INDUSTRIAL APPLICATIONS AND ECONOMIC ASSESSMENT OF AOPs 10

Application of AOPs for Textile, Petroleum, Pharmaceutical and Petrochemical industries - ground water decontamination – Drinking Water Treatment – Cost calculation– Economic analysis.

TOTAL: 45 PERIODS

COURSE OUTCOME:

On Completion of the course, the student is expected to be able to

CO1 Comprehend the basic principles of advanced water treatment processes, capabilities/constraints of their application in water and wastewater treatment

CO2 Apply technical knowledge and skills on the design and operation of AOPs for the water and wastewater treatment

CO3 Design suitable pre-treatment scheme, post treatment scheme, and cleaning protocols for AOPs

CO4 Explain the mechanism of AOP processes in different applications in environmental protection and conduct economic assessment on AOTs for water and wastewater treatment

CO5 Develop innovative and economically viable technologies in AOP to treat wastewater contaminated with toxic pollutants .

REFERENCES:

1. Maulin P. Shah, Sweta Parimita Bera, Gunay Yildiz Tore, “Advanced Oxidation Processes for Wastewater Treament – An Innnovative Approach”, CRC Press, 2022.
2. Suresh Ameta, Rakshit Ameta, “Advanced Oxidation Process for Wastewater Treatment – Emerging Green Chemical Technology”, Academic Press, 2018.
3. Mihaela I. Stefan, “Advanced Oxidation Processes for Water treatment: Fundamentals and Applications”, IWA Publishing, 2017.
4. Marta.I.Litter, Roberts J. Candal, J. Martin Meichtry, "Advanced Oxidation Technologies: Sustainable Solution for Environmental Treatment”, CRC Press, 2014.

5. G. Tchobanoglous, H.D. Stensel, R. Tsuchihashi, F.L. Burton, Wastewater Engineering: Treatment and Reuse Recovery, McGraw-Hill Higher Education, 5th edition, 2013.
6. J.C. Crittenden, R. Trussell, D.W. Hand, K.J. Howe, G. Tchobanoglous, Water Treatment, Principles and Design, John Wiley & Sons, 3rd Edition, 2012.
7. Simon Parsons, "Advanced oxidation processes for water and wastewater treatment", IWA Publishing, 2005.
8. Cao G., "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.
9. Thomas Oppenlander, "Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts", Wiley-VCH Publishing, 2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	2	2	3	3	2
CO3	2	2	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	3	3	3	3	3
Avg	**3**	**2**	**3**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3003 ENVIRONMENTAL AND SUSTAINABILITY PLANNING L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Principles of Environmental and Sustainability planning – Indicators of Sustainability - Sustainability Strategies - Barriers to Sustainability – Environmental Planning process - Ethical issues in environmental planning - Environmental approaches to design and Planning - Socio Economic Policies.

UNITII PLANNING FOR SUSTAINABLE PUBLIC HEALTH AND EQUITY 8

Integrated water planning – National water Policy - Eco friendly treatment systems - concept of decentralization - Wastewater management policy and models - Environmental Management Hierarchy - Principles and Concepts of Cleaner Production - Economic Valuation of Alternatives.

UNIT III PLANNING FOR NATURAL AREAS AND LANDSCAPES 10

Coastal zone management – Planning for natural hazard and disasters – Farm land and eco village – Ecotoxicology - Hazards by Industry and its Environmental Effects - Relationship of Occupational Hygiene / Safety and Disease - Hazard Identification and Risk Assessment - Response to Toxic Exposures - Dose Response Relationship.

UNIT IV PLANNING FOR THE BUILT ENVIRONMENT 9

Ecological Design - Green House Gases and Carbon Credit - Carbon Sequestration- Carbon Trading - Integrated Models - Climate modifications and management - Adaptation and mitigation measures to make resilient cities – Carrying Capacity and its limits - Social Capital and its limits - Ecological Foot print - Green building concepts.

UNITV PLANNING FOR POLLUTION PREVENTION 10

Environmental Management Systems – ISO 14000 - Environmental Auditing – Eco labeling - Life cycle Assessment - Design for Environment - Economics of pollution prevention - Cost Benefit Analysis - Circular economy - Economic instruments for environmental protection - Pollutant tax and emission trading - Emerging Trends and Technologies.

TOTAL: 45 PERIODS

COURSE OUTCOME:

On Completion of the course, the student is expected to be able to

CO1 Explain the principles of Environmental planning process and identify the issues in environmental designing and planning

CO2 Apply the technical planning skills for integrated water and wastewater management

CO3 Identify the environmental hazards and adapt mitigation measures for sustainable public health

CO4 Develop the integrated models and tools for environmental protection

CO5 Conduct research to develop emerging technologies for pollution prevention

REFERENCES:

1. Allen D.T and Shonnard D.R., Sustainability Engineering: Concepts, Design and case studies, Pretice hall
2. Bradley A.S, Adebayo A.O, Maria P., Engineering Applications in Sustainable esign and Development, Cengage learning
3. Tracer Strange and Anne BAley ,"Sustainable Development –Linking economy, Society, environment" , StatLink from OECD Publishing 2008.
4. J. Kirkby, P. O'Keefe and Timberlake, Sustainable Development, Earthscan Publication, London, 1999.
5. Environmental Impact Assessment Guidelines, Government of Indi, 2006
6. Ni bin chang, System Analysis for Sustainable Engineering: Theory and Applications, Mc-Graw-Hill Professional.
7. P.L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	3	2	2	3
CO3	3	2	3	2	2	3
CO4	3	2	3	3	3	3
CO5	3	3	2	3	3	2
Avg	**3**	**2**	**3**	**2**	**2**	**3**

• 1-low, 2-medium, 3-high

EN3004 AQUATIC ECOSYSTEM AND CONSERVATION L T P C

3 0 0 3

UNIT I BASIC CONCEPTS OF AQUATIC ECOSYSTEMS 9

Hydrosphere - Hydrological Cycle, Aquatic ecosystem types - Freshwater, Wetlands, Estuarine and Marine ecosystems – components of aquatic ecosystems – abiotic, biotic - Community structure – planktons, nektons, benthos - aquatic ecosystem functions – spatial pattern – stratification, zonation, Aquatic productivity – primary productivity, secondary productivity, net productivity – Decomposition – fragmentation, leaching, catabolism, humification, mineralization - Energy flow – energy loss, ecological pyramids - Threats to aquatic biodiversity – Various conventions and regulations concerning biodiversity.

UNIT II FRESHWATER ECOSYSTEM 9

Characteristics – Types - Lentic water bodies – ponds – lakes – types based on origin – based on thermal stratification – reservoirs – lotic water bodies – streams – springs – major Indian rivers – wetlands - Evolution of Organisms and Biodiversity of Freshwaters - Ecological Succession - Ecosystem services - Types – primary, secondary productivity – Trophic levels - Nutrient cycle – gaseous, sedimentary, climate change and impacts on lakes and reservoirs.

UNIT III MARINE AND COASTAL ECOSYSTEMS 9

The Sea Floor - Chemical and physical Factors – carbonate systems, dissolved gases - Fauna and flora diversity – ecological characteristics and perspectives– brackish water – estuary – mangroves – intertidal coral reefs - sea grasses – seaweeds – pelagic – deep sea – hydrothermal vents – Economic

and pharmacological bio resources – Drugs from marine plants and animals – Biodiversity in Arctic and Antarctic oceanic environment.

UNIT IV ECOLOGICAL ADAPTATION OF AQUATIC FAUNA AND FLORA 9

The Impact of Humans on the Marine Environment - Primary and secondary adaptations – Marine biodiversity conservation programmes – In-situ conservation - Ex-situ conservation - World marine bio-reserves – Great Barrier Reef programme – IUCN - Marine bio-reserves in India – National biodiversity action plan, - Marine Pollution and Ballast Water - Protection and preservation of marine biodiversity - Regional Sea Agreements.

UNIT V AQUATIC ECOSYSTEM MONITORING 9

Indicators for monitoring aquatic ecosystems – Physico-chemical indicators – pH, temperature, nutrients – Biological indicators – microorganisms, plants, animals - light transmission in the water column – Dissolved oxygen –collection and identification of hydrophytes – wetland plants and animals – Estimating population – Abundance estimation – Working out biodiversity indices - Standardized survey methods.

TOTAL: 45 PERIODS

COURSE OUTCOME:

On Completion of the course, the student is expected to be able to

CO1 Identify the causes of aquatic ecosystem degradation and eliminate or remediate the issues and Summarise the national and international laws on aquatic environment

CO2 Compare issues and strategies in ecosystem management between freshwater, coastal, and marine system

CO3 Describe the impact of human activities on natural aquatic environments and current management tools that are being implemented to restore or protect aquatic ecosystems

CO4 Apply natural solutions and bioengineering techniques for erosion control and bank stabilization, flood mitigation, and water treatment.

CO5 Assess the current situation (including the identification of conflicts and priorities), formulate visions, set goals and targets, and orient operational management

REFERENCES:

1. Philip J. Boon and John M. Baxter, “Aquatic Conservation – Marine and FreshwaterEcosystem”, Joohn Wiley & Sons Ltd, 2021.
2. Mamta Rawat, Sumit Dookia, Chandrakasan Sivaperuman, “Aquatic Ecosystem: Biodiversity, Ecology and Conservation”, Springer, New Delhi, 2015.
3. T. V. Ramachandra, Ahalya N., C. Rajasekara Murthy, “Aquatic Ecosystems: Conservation, Restoration, and Management”, 2005.
4. Dobson, M. “Ecology of Aquatic Management” Pearson Education, 2000
5. Singh G. K. and Nautial K. C., “Biodiversity and Ecology of Aquatic Environment”,Narendra Publisihing House, 2009.
6. Dodds, W. K., “Fresh Water Ecology-Concepts and Environmental Applications”, Academic Press, 2002.
7. Raymundo E. R., “Wetlands: Ecology, Conservation and Restoration”, Nova Science Publishers, 2008.
8. Maltby E., “Functional assessment of wetlands - Towards evaluation of ecosystemservices”, Woodhead Publishing Limited, Cambridge, UK, 2009.
9. Wetzel, R.G., “Limnology: Lake and River Ecosystems”, Academic Press, 2000.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	2	2	2	2	2	2
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	2	3	3	2	2	2
Avg	**3**	**2**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

EN3005 ENVIRONMENTAL REACTION ENGINEERING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Reaction engineering principles with applications to environmental systems, general reaction mechanisms: Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation solidification and stabilization– Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends. Rate relationships: Concepts and applications to homogenous systems and heterogeneous systems with respective chemical and biological reactions.

UNIT II POLLUTANTS AND REACTIONS IN ENVIRONMENT 9

Reaction leading to generation of pollutants, impact of pollutants and theirs reactions in environment, ozone depletion, smog formation, acid rain, chemical reactions in major treatment technologies- gas –solid catalytic reactions, catalytic oxidation of VOCs, incineration, selective catalytic reduction. Gas –liquid reaction FCC (fluid catalytic cracking) off gas cleaning, wet- gas scrubbing, H_2S removal and spent caustic oxidation.

UNIT III REACTORS MODELLING AND DESIGN 9

Ideal systems modeling and design, reactor concepts, ideal reactors, reaction rate measurements, hybrid system modeling and design, sequencing batch reactor, reactors in series and reactors in recycle. Non-ideal system modeling and design, non-ideal reactor behavior, RTD analysis, PFDR model

UNIT IV MASS TRANSFER AND ITS APPLICATIONS IN ENVIRONMENTAL ENGINEERING 9

Principles of diffusion and mass transfer between phases, Gas absorption, humidification operations, leaching and extraction, drying of solids, fixed-bed separation, membrane separation process, fluid solid surface reactions, Gas-liquid bulk phase reaction, adsorption.

UNIT V BIOLOGICAL REACTION ENGINEERING 9

Biological kinetics, enzyme kinetics, Michaelis – Menden equation, bioreactors, Batch and continuous operation in bioreactors, Aerobic processes: Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. b) Anaerobic processes: Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactor. bio concentration, bioaccumulation, biomagnification, bioassay, bio monitoring. Biotechnology in reduction of CO_2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications. Vermitechnology, Methane production, Root zone treatment, Membrane technology, Biodegradable plastics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, graduates are expected to attain the following outcomes:

CO1: Successfully apply advanced concepts of fundamental sciences and engineering to identify, formulate, and solve complex environmental engineering problems.

CO2: design, analyze, and develop technologies to meet desired needs of society, both, professionally and ethically.

CO3: Be knowledgeable of contemporary issues and research challenges/opportunities related to chemical and environmental engineering, and engage in life-long learning to keep abreast of such issues.

CO4: Use advanced techniques, skills, and modern scientific and engineering tools for problems related to professional practice in the field of environmental reaction engineering.

REFERENCES

1. Weber, W.J and Di Giano, F.A., "Process Dynamics in Environmental systems", John Wiley sons Inc, 1996.
2. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017

3. Dunn I.J, Elmar Heinzle, John Ingham, Prenosil J.E, „Biological reaction engineering", Wiley inter science, 2005.
4. Levenspiel, O. *Chemical Reaction Engineering*. 3rd ed. New York, NY: Wiley, 1999. ISBN: 9780471254249.
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6. Steinfeld, J. I., J. S. Francisco, and W. L. Hase. *Chemical Kinetics and Dynamics*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1999. ISBN: 9780137371235.
7. Bailey, J. E., and D. F. Ollis. *Biochemical Engineering Fundamentals*. 2nd ed. New York, NY: McGraw-Hill, 1986. ISBN: 9780070032125.
8. Stephanopoulos, G., A. Aristidou, and J. Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, CA: Academic Press, 1998. ISBN: 9780126662603.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	2	3
CO2	2	1	2	3	2	3
CO3	2	1	2	3	2	3
CO4	2	1	2	3	2	3
CO5	2	1	2	3	2	3
Avg	**2**	**1**	**2**	**3**	**2**	**3**

• 1-low, 2-medium, 3-high

EN3006 NATURAL SYSTEMS FOR WASTEWATER TREATMENT L T P C
3 0 0 3

UNIT I INTRODUCTION TO WETLAND TREATMENT SYSTEM 9

Definition and concept of wetland - types of wetland. Wetland - ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications. Introduction to constructed wetland-types-free water surface, subsurface wetland-horizontal and vertical flow- wastewaters and their application in wetland - constructed wetland plants-media – in constructed wetland.

UNIT II CONSTRUCTED WETLAND AND REMOVAL MECHANISMS 9

Site identification- construction and design of constructed wetland, startup, operation and maintenance of wetland system-wetland hydrology- hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal- suspended solids, organic matter, nitrogen, phosphorus, pathogen and other contaminants. Reuse of treated wastewater and its applications-limitation of constructed wetland system.

UNITIII CASE STUDIES ON CONSTRUCTED WETLAND SYSTEM 8

Constructed wetland- treatment of domestic wastewater- greywater - landfill leachate – treatment of industrial wastewaters- textile wastewater – dairy wastewater and its performance. Removal of specific pollutants such as heavy metals, aromatics and emerging contaminants etc. Use of amendments in wetland construction, and its performance. Capital and maintenance costs.

UNIT IV DESIGN OF WASTEWATER POND SYSTEMS. 10

Introduction- facultative -partial -mix aerated- ponds -complete -mix aerated pond systems -anaerobic ponds -nitrogen removal in lagoons. Modified high -performance aerated pond systems for nitrification and denitrification - nitrogen removal in ponds coupled with wetlands and gravel bed nitrification filters -Control of algae and design of settling basins. Hydraulic control of ponds -removal of phosphorous -removal of pharmaceuticals and personal care products and antibiotic resistant genes.

UNIT V SLUDGE MANAGEMENT AND TREATMENT 9

Sludge quantity and characteristics - stabilization and dewatering -sludge freezing -reed beds - vermi stabilization -comparison of bed type operations -composting land application and surface disposal

of bio solids onsite wastewater systems -effluent disposal and reuse. Sludge quantity and characteristics-stabilization and dewatering-sludge freezing reed beds-vermi stabilization-Comparison of bed-type operations-composting land application and surface disposal of biosolids-on-site wastewater systems- effluent disposal and reuse.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain the various aspects of wetland system, its function and its application in the treatment of wastewaters

CO2 Apply the knowledge of science and engineering to know the types of wetlands, construction and operation of wetlands, wetland hydraulics.

CO3 Understand the process of treatment of industrial wastewater using wetland system.

CO4 Understand the various pond system available for wastewater treatment. Design of pond system -removal mechanism

CO5 Manage and dispose the sludge naturally and economically.

REFERENCES:

1. EPA- Design Manual on constructed wetland and aquatic plant system for municipal wastewater treatment system
2. Treatment wetlands by Robert .H.Kadlec, Scott Wallace , CRC press published July 22, 2008
3. Natural Wastewater Treatment Systems, Ronald W. Crites, E. Joe Middlebrooks, Robert K. Bastia, 2nd Edition, CRC PressPublished March 14, 2014
4. Waste water treatment in constructed wetlands with horizontal sub- surface flow by Jan Vyamazal and Lenka Kropfelova, Springer 2010.
5. Constructed wetlands for industrial wastewater treatment system by Alexandros I.Stefanakis (editor), Wiley black well.2018

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	3
CO2	1	3	2	3	2	1
CO3	2	2	2	2	2	2
CO4	2	2	1	2	2	1
CO5	1	2	1	2	1	2
Avg	2	2	2	2	2	2

• 1-low, 2-medium, 3-high

EN3007 SOFT COMPUTING IN ENVIRONMENTAL ENGINEERING **L T P C**
3 0 0 3

UNIT I SOFT COMPUTING PRINCIPLES **9**

Introduction to soft computing techniques – algorithms and flowcharts, numerical methods - solution to ordinary and partial differential equation using finite difference, finite element and finite volume methods, Environmental modeling.

UNIT II ARTIFICIAL INTELLIGENCE **9**

Principle of Artificial Neural Network (ANN) –perception learning rule, neural network structure – neural network operations – ANN Algorithm – genetic algorithms – Application of ANN Model to Environmental studies

UNIT III FUZZY LOGIC IN ENVIRONMENTAL STUDIES **9**

Fuzzy logic principles – fuzzy logic and the theory of uncertainty – fuzzy set theory – fuzzy membership function, fuzzy relations, fuzzy rule, and applications of the fuzzy logic in environmental studies – case studies

UNIT IV DIGITAL DATA MANAGEMENT **9**

Data base structure - data acquisition - data warehouse - DBMS - RDBMS - data analysis - Statistical Analysis - regression - factor analysis - histogram – scatter diagram – goodness of fit — big data analysis.

UNIT V ENVIRONMENTAL MODELING SOFTWARE **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the students are able to

CO1 Understand the various computing techniques available for environmental engineering.
CO2 Apply the principles of ANN and GA for solving environmental problems
CO3 Apply the principles of Fuzzy logic and for solving environmental problems.
CO4 Work in the statistical analysis software SYSTAT.
CO5 Employ modern advanced computing tool MATLAB software in environmental studies

REFERENCES:

1. Aliev R.A, and Aliev Rashad, "Soft Computing and its Applications", World Scientific Publications Co. Pte. Ltd. Singapore, 2021.
2. Soft Computing: Neuro-Fuzzy and Genetic Algorithms, by Samir Roy and Udit Chakraborty, Pearson India Education Services Pvt. Ltd (2022)
3. 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, NewYork, NY10020. 6th Edition 2022.
4. Data-Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering, Springer; 2022 edition.
5. Mathews J. H. and Fink K.D. "Numerical methods using MATLAB", Pearson Education 2022.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	2	2
CO2	2	3	3	3	2	3
CO3	3	3	3	2	3	3
CO4	3	1	2	2	3	3
CO5	3	3	2	3	3	3
Avg	**3**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3008 DESIGN OF ENVIRONMENTAL ENGINEERING STRUCTURES **L T P C**
3 0 0 3

UNIT I STRUCTURAL DESIGN INSIGHTS AND DESIGN OF PIPES **9**

Environmental engineering structures - Introduction - concept of elastic method, ultimate load method and limit state method – advantages of limit state method over other methods – limit state philosophy as detailed in current IS Code. Structural design of - concrete, prestressed concrete pipes – anchorage for pipes – massive outfalls, advances in the manufacture of pipes.

UNIT II DESIGN OF WATER TANKS **9**

IS Codes for the design of water retaining structures - design of concrete roofing systems — cylindrical, spherical and conical shapes - design of circular, rectangular, spherical and INTZE type water tanks

UNIT III DESIGN OF WATER TREATMENT PLANT STRUCTURES **9**

Structural design of screen chamber, settling tank, clariflocculators, filters and service reservoirs.

UNIT IV DESIGN OF WASTEWATER TREATMENT PLANT STRUCTURES 9

Structural design of wastewater treatment units – grit chamber, aeration tank, sludge digester, UASBR, sludge thickener, sludge drying beds.

UNIT V SPECIAL STRUCTURES 9

Design of masonry walls, columns and footings as per NBC and IS Codes – swimming pools, intake towers – design of cyclone separator – scrubber.

TOTAL: 45PERIODS

COURSE OUTCOMES:

- On completion of the course, the students are able to

CO1 Apply the principle of limit state design for concrete pipe design
CO2 Do structural design of Water tanks
CO3 Design the water treatment plant Structures.
CO4 Design the components of wastewater treatment plant structures.
CO5 Apply the knowledge of structural design to various environmental engineering structures.

REFERENCES:

1. "Prestressed Concrete" byKrishnaRaju,Tata McGrawHill Publishing Co 2021.
2. "Reinforced Concrete" by N.C.Sinha & S.K.Roy - S.Chand and Co. 2017
3. Ramaswamy, G.S., “Design and Construction of Concrete shellroofs", CBS Publishers, India, 2005.
4. Green, J.K. and Perkins, P.H., “Concrete liquid retaining structures", Applied Science Publishers,1981.
5. Rajagopalan K., "Storage structures", Tata McGrawHill, NewDelhi, 2016.
6. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, NewDelhi, 2022.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	2	1	3	3	2	2
CO3	3	3	3	2	3	3
CO4	3	1	2	2	3	3
CO5	3	3	2	3	3	3
Avg	**3**	**2**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3051 MARINE POLLUTION AND CONTROL L T P C
3 0 0 3

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, salt marshes, mangroves and sand dunes – the oceans and climate, coastal zone regulation in india – national and international treaties.

UNIT II OCEAN HYDRODYNAMICS 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 Nino and La Nina effect.

UNIT III MARINE POLLUTION 9

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

UNIT IV MARINE POLLUTION MONITORING **9**

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

UNIT V MARINE POLLUTION CONTROL MEASURES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the students are able to

CO1 Know about the different components of marine environment.
CO2 Understand physical concepts lying behind the tides, waves, and oceanic currents and natural processes of various activities happening over the marine environment
CO3 Identify and measure the marine pollution levels and effects
CO4 Apply the knowledge of remote sensing and GIS for monitoring marine environment water quality.,
CO5 Develop marine pollution control measures.

REFERENCES:

1. "Marine Pollution R.B. Clark, C. Frid and M Atttrill, Oxford Science Publications, 5th Edition, 2021.
2. Marine Pollution: New Research - TobiasN. Hofer,Nova Publishers, 2018,
3. Laws, E.A., "Aquatic pollution", an introductory text. John Wiley and Sons, Inc., New York, 2007.
4. Practical Handbook of Estuarine and Marine Pollution, Michael J. Kennish, Volume 10 of CRC Marine Science, CRC Press, 2021

CO-PO MAPPING

1.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	2	3
CO2	1	3	2	3	2	3
CO3	3	3	3	2	3	2
CO4	3	3	2	3	3	3
CO5	2	2	3	3	3	3
Avg	**2**	**3**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3009 WATER QUALITY AND MODELLING **L T P C**
3 0 0 3

UNIT I MODELLING IN SIGHTS **9**

Engineers and Mathematical models - Water quality models — historical development – different types of models - steps in model development - importance of model building - calibration and verification of models – water quality – model sensitivity —assessing model performance - finite element, finite difference and finite volume methods

UNIT II POLLUTANT TRANSPORT` **9**

Transport phenomena — advection, diffusion, dispersion - contamination transport in surface and subsurface water - Simple transport models – steady state and time variable solutions – conservation of mass, momentum and energy balance, governing equation for contaminant fate and transport

UNIT III SURFACE WATER QUALITY MODELLING 9

Water quality modeling of streams, lakes and estuaries —; Models for dissolved oxygen, pathogens and BOD - Streeter Phelp's model for point and distributed sources - modified streeter Phelp's equations. Tropic status assessment.

UNIT IV GROUNDWATER QUALITY MODELLING 9

Groundwater flow and mass transport of solutes – groundwater quality modeling using numerical methods - degradation of organic compounds in sub surface - prediction of contaminant transport and particle tracking – seawater intrusion basic concepts and modelling.

UNIT V WATER QUALITY MODELLING SOFTWARE 9

Exposure to surface water and ground water quality modeling software's – MIKE21, WASP, QUAL2E and MODFLOW – demonstration – case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the students are able to

CO1 Know about the principles of water quality modelling.
CO2 Understand the pollutant transport phenomena in surface and groundwater.
CO3 Apply the knowledge of surface water quality modeling to predict the water quality of rivers, lakes and estuary.
CO4 Predict the groundwater contamination transport.
CO5 Predict water quality of surface and sub-surface water using numerical solution.

REFERENCES:

1. Steven C. Chapra, "Surface Water Quality Modelling", Tata McGraw-Hill Companies, Inc., New Delhi 2022.
2. "Water Quality Modelling for Rivers and Streams" Authors: Benedini, Marcello, Tsakiris, George, Springer Netherlands 2017.
3. **"**Hydrodynamics and Water Quality**:** Modelling Rivers, Lakes, and Estuaries", Zhen - GangJi, John Wiley & Sons, 2018.
4. "Modelling Groundwater Flow and Contaminant Transport By Jacob Bear, A.H. - D. Cheng, Springer Science & Business Media, 2021.
5. "Mathematical Modelling of Groundwater Pollution" Ne-Zheng Sun, Alexander Sun, Springer New York, 2012

CO-PO MAPPING

1.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	2	3
CO2	1	3	2	3	2	3
CO3	3	3	3	2	3	2
CO4	3	3	2	3	3	3
CO5	2	2	3	3	3	3
Avg	**2**	**3**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3010 ENVIRONMENTAL SYSTEM ANALYSIS L T P C
3 0 0 3

UNIT I ECOLOGICAL SYSTEM 9

Basic concepts in ecology and ecological modeling, Population Dynamics: Birth and death processes. Single species growth, Prey-predator models: Lotka-Volterra, Rosenzweig-MacArther, Kolmogorov models. Multi-species modeling - Structural analysis and stability of complex ecosystems.

UNIT II REACTOR MODELING **9**

CSTR, Plug-Flow, Dispersion. A case study of a tubular reactor with axial dispersion, Parameter Calibration: Search algorithms for nonlinear dynamical models, Variance of estimated parameters. Application to Monod and Haldane kinetics.

UNIT III WATER QUALITY MODELING **9**

Rivers and streams water quality modeling -dispersion and mixing- water quality modeling process-model sensitivity-assessing model performance; Models for dissolved oxygen and pathogens-Pollutant and nutrient dynamics -Dissolved Oxygen dynamics -Groundwater quality modeling.

UNIT IV MICROBIAL DYNAMICS AND ENERGETICS **9**

Requirements for carbon and nutrient removal. Activated sludge: Process schemes: completely mixed, plug-flow, SBR, nutrient removal. Anaerobic digestion: process dynamics, Operational control of wastewater treatment processes.

UNIT V COMPUTER BASED SOLUTIONS **9**

Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models- simulation, parameter estimation and experimental design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the students are able to

CO1 Apply the principle of system modeling
CO2 Do reactor modeling
CO3 Develop water quality models.
CO4 Model microbial dynamics
CO5 Apply the knowledge of numerical techniques to environmental system modeling

REFERENCES:

1. Deaton, M.L and Winebrake, J.J., "Dynamic Modeling of Environmental Systems", Springer-Verlag, 2000
2. Environmental Systems: Philosophy, Analysis and Control, Robert John Bennett and Richard J. Chorley, Princeton University press (2022).
3. Chapra, S.C. "Surface Water-Quality Modeling", McGraw-Hill, 2022.
4. Environmental Systems Analysis with MATLAB® Hardcover – 3 March 2016 by Stefano Marsili-Libelli, CRC Press; (2021)

CO-PO MAPPING

1.	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	2
CO2	2	1	3	3	2	3
CO3	3	3	3	2	3	3
CO4	3	1	2	1	3	3
CO5	3	3	2	3	3	3
Avg	**3**	**2**	**2**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

EN3011 ENVIRONMENTAL MONITORING INSTRUMENTS **L T P C**
3 0 0 3

UNIT I FUNDAMENTALS **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- Nanomaterials for Environmental Analysis

UNIT II SPECTROSCOPIC METHODS 12

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

UNIT III CHROMATROGRAPHIC METHODS 8

Principles, techniques and applications of GC, GC-MS, high performance liquid chromatography (HPLC) and Ion Chromatography (IC)-hyphenated techniques for environmental contaminant (trace organics) analysis, Electrophoresis, LC-MS

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS 8

Principles, techniques and applications of conductometry, potentiometry, coulometry, AOX Analyzer. amperometry, polarography, electro-capillary analysis, Neutron 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 SO_2- particulates analysis- auto analyzer for water quality using flow injection analysis. LIMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to select appropriate instrumental method for chemical analysis
CO2: Understand spectroscopic methods of analysis of pollutants
CO3: Select correct method for toxic organics estimation using chromatography methods
CO4: Understand electro and nondestructive methods of analysis
CO5: Familiar with online analyzers

REFERENCES:

1. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. 'Instrumental methods of analysis , 7th Edn. Words Worth, New York, 2004.
2. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications, Marcel Dekker; 2nd Edition , 2005,
3. Ewing and Galen W, Instrumental Methods of Chemical Analysis, 5th Edition, McGraw Hill, NewYork.2013
4. Reeve, R.N., "Introduction to Environmental Analysis", Analytical Techniques in the Sciences, John Wiley & Sons, Chichester, UK, 2002.
5. Chaudhery Mustansar Hussain and Rustem Kecili , Modern Environmental Analysis Techniques for Pollutants, Elsevier,1st Edition - , 2019

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	3
CO2	1	1	2	2	1	2
CO3	1	1	2	2	1	2
CO4	1	1	2	2	1	2
CO5	1	1	2	2	1	2
Avg	**1**	**1**	**2**	**2**	**1**	**2**

• 1-low, 2-medium, 3-high

EN3052 MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT L T P C 3 0 0 3

UNIT I MEMBRANE FILTRATION PROCESSES 10

Membrane filtration for solid Liquid separation- crossflow filtration–History of Development and Recent advancements- Basic terms and principles- Recovery, Flux, Rejection, Fouling - membrane flux and trans membrane pressure-Theory of membrane separation– mass transport characteristics–porous and non porous filtration models – concentration polarisation types and

choice of membranes –membrane structures and materials – plate and frame, spiral wound and hollow fibre membranes –membrane performance factors and considerations – membrane manufacturing process.

UNIT II MEMBRANE SYSTEMS 10

Membrane module/element designs – membrane system components– design of membrane systems – design of modules,assembly,plant process control and applications –Basic Flow patterns-Arrays, recycle, Double Pass, multiple Trains- design and applications of low pressure membrane technology systems-microfiltration and ultrafiltration- design and applications of diffusive membrane technologies- nanofiltration and reverse osmosis–Normalised Permeate Flow and Salt Rejection–electrodialysis:Ionexchangemembranes, process design- design of membrane systems – pump types and pump selection–plant operations– economics of membrane systems

UNIT III MEMBRANE BIOREACTORS 8

Historical perspective of MBRs-biotreatment fundamentals-MBR principles and fundamentals-MBR design principles, design assignment, alternative MBR configurations – commercial technologies-Membranes, Modules, and Cassettes - Process Flow of Wastewater Treatment Plants Using MBR - fouling and fouling control- Reversible versus Irreversible and Recoverable versus Irrecoverable Fouling - MBR Operation- Aeration for Biotreatment and Membrane Aeration- trouble Shooting-Case Studies of the MBR Processes Using Popular Membranes

UNIT IV PRETREATMENT AND POST TREATMENT SYSTEMS 8

Membrane fouling–source water quality characterization- particulate membrane foulants - mineral membrane-scaling foulants - natural organic foulants- microbial foulants- parameters and measurement methods- Langlier index, silt density index -combined impacts of various types of foulants- control of fouling-pretreatment methods and strategies–source water screening and conditioning- Mechanical pretreatment-Chemical Pretreatment-monitoring of pretreatment–chemical cleaning systems- biofoulant control – post treatment systems

UNIT V CASE STUDIES 9

Casestudiesonthedesignofmembranebasedwaterandwastewatertreatmentsystems – RO Design Software–zero liquid effluent discharge plants–desalination of brackish water and seawater – project implementation and project economics – environmental issues –reject management -energy recovery systems –Issues concerning system engineering –operation and maintenance issues and good operational practices

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain the various main membrane processes, principles, separation mechanisms, and applications

CO2 Apply the knowledge of science and engineering fundamentals to analyse the mechanisms of membrane filtration

CO3 Design of membrane systems involving microfiltration, ultrafiltration, nanofiltration, reverse osmosis, electrodialysis and membrane bioreactor processes

CO4 Select appropriate membrane technologies for water and wastewater treatment taking into account the impact of the solutions in a sustainability context

CO5 Conduct research pertinent to membrane technology applications to water and wastewater treatment and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

1. Mihir K. Purkait, Randeep Singh, Membrane Technology in Separation Science, CRC Press, 2018
2. Jane Kucera, Reverse Osmosis: Industrial Processes and Applications, wiley 2015
3. Nikolay Voutchkov, Desalination Engineering-Planning and Design, McGraw-Hill,Newyork,2013
4. SymonJud, MBR Book "Principles and application of MBR in water and wastewater treatment", Elservier, 2010.

5. Hee-Deung Park In-Soung Chang Kwang-Jin Lee, Principles of Membrane Bioreactors for Wastewater Treatment, CRC Press, 2015
6. A.F. Ismail, Takeshi Matsuura, Membrane Technology for Water and Wastewater Treatment, Energy and Environment, CRC Press, 2016
7. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse fourth Edition, McGraw-Hill, 2017

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	2
CO2	2	1	3	3	2	2
CO3	2	1	3	3	2	2
CO4	2	1	3	3	2	2
CO5	2	1	3	3	2	2
Avg	**2**	**1**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3012 EMERGING CONTAMINANTS L T P C
3 0 0 3

UNIT I SOURCES, OCCURRENCE AND REGULATORY REQUIREMENTS 10

Definition - Priority *vs.* emerging contaminants - Recent concerns - Major groups - Examples - Properties - Sources - Occurrence - Distribution in soils, groundwater, industrial and municipal wastewaters, aquaculture effluents, freshwater and marine ecosystems, air, food, plants, animals and human blood - Existing global regulatory frameworks and policies

UNIT II CHARACTERIZATION AND INSTRUMENTATION 7

Sampling – Sample preparation methods – Analytical protocols for detection of pharmaceuticals, personal care products, antimicrobials and antibiotics, hormones, phthalate plasticizers and degradation products, surfactants, brominated fire retardants, pesticides and nanoparticles – Analytical instruments

UNIT III ENVIRONMENTAL FATE AND TRANSPORT 9

Sorption - Leaching - Runoff - Erosion - Volatilization - Plant/animal uptake - Degradation and transformation - Human health and ecological risks - Environmental fate modelling frameworks - Risk assessment tools - Challenges - Biomonitoring and biosensors

UNIT IV REMEDIATION TECHNOLOGIES 10

Incineration - Sonolysis - Multi-phase extraction - Permeable reactive barrier - Advanced oxidation processes - Membrane based separation - Nanofiltration - Reverse osmosis - Biosorption - Bioaugmentation - Combined treatment options - Remediation endpoints - Challenges - Opportunities

UNIT V CASE STUDIES 9

Occurrence in different environmental compartments - Environmental fate and transport - Potential and known risks to human health and the environment - Effective technological and policy approaches to prevent, control and remove emerging pollutants in the environment

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to:

CO1 Explain about the different kinds of emerging contaminants, their sources, occurrence, distribution in different environmental compartments and existing regulations/policies

CO2 Explain about the analytical techniques for the detection of emerging contaminants in environment

CO3 Explain about the environmental fate, behaviour, underlying mechanisms, human health and ecological risks of emerging contaminants, and will be able to monitor and assess the degree of environmental contamination by emerging pollutants

CO4 Select an appropriate single and/or integrated physical, chemical and/or biological clean-up option for environments contaminated with different classes of emerging pollutants in order to achieve the target remedial endpoints

CO5 Conduct independent research in the future pertinent to emerging contaminant pollution and remediation

REFERENCES:

1. Alok Bhandar, Rao Y Surampalli, Craig D Adams, Pascale Champagne, Say Kee Ong, Tyagi R D and Tian Zhang, Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, US, 2009.
2. Damia Barcelo, Emerging Organic Contaminants and Human Health, Springer, Germany, 2012.
3. Caitlin H Bell, Margaret Gentile, Erica Kalve, Ia Ross, John Horst and Suthan Suthersan, Emerging Contaminants Handbook, CRC Press, US, First edition, 2018.
4. Francisco G, Calvo-Flores, Joaquin Isac-Garcia, Jose A Dobado, Emerging Pollutants: Origin, Structure and Properties, Wiley & Sons, US, 2018.
5. Kathleen Sellers, Denice K Nelson and Nadine Weinberg, Emerging Contaminants – Anticipating Developments, CRC Press, US, 2020.
6. Nadia Morin-Crini, Eric Lichtfouse and Grégorio Crini, Emerging Contaminants Occurrence and Impact, Springer, Germany, 2021.
7. Jeyaseelan Aravind and Murugesan Kamaraj, Emerging Contaminants – Remediation Technologies, De Gruyter, Germany, 2022.
8. Willis Gwenzi, Emerging Contaminants in the Terrestrial-Aquatic-Atmosphere Continuum: Occurrence, Health Risks and Mitigation, Elsevier, Netherland, 2022.

CO-PO MAPPING

1.	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	2	3	2	2	2
CO3	2	2	2	2	3	2
CO4	3	2	3	2	2	3
CO5	3	2	3	2	2	2
Avg	3	2	3	2	2	2

• 1-low, 2-medium, 3-high

EN3013 PROJECT FORMULATION AND IMPLEMENTATION L T P C
3 0 0 3

UNIT I INTRODUCTION TO PROJECT FORMULATION 9

Concept of project formulation – Need for project formulation - Significance of project formulation – Phases in project cycle - Methods and Tools for project formulation - Search for project ideas - Screening of project ideas - Formulation of the projects: Proposal and project report preparation guidelines and models

UNIT II PROJECT FEASIBILITY ANALYSIS 9

Types and importance of project feasibility studies – Technical feasibility – Economic feasibility – Legal feasibility – Operational feasibility – Scheduling feasibility - Techniques for demand forecasting - Project cost determination – Sources of finance – Profitability estimates - Cash flow estimates – Project risk and uncertainties – Steps to conduct a project feasibility study

UNIT III PROJECT APPRAISAL 9

Technical appraisal checklist – Financial appraisal – Institutional appraisal – Commercial appraisal – Environmental appraisal - Economic appraisal - Legal appraisal – Project appraisal methods –

Project analysis as per cash flow – Net present value – Benefit-cost ratio – Internal rate of return – Key issues – Preparing project appraisal report - Case study of good appraisal

UNIT IV PROJECT FINACING AND IMPLEMENTATION 10

Key features of project financing – Various stages of project financing: Pre-financing, financing and post-financing – Types of sponsors/ funding agencies in project financing: Industrial, public, contractual and financial – Financial evaluation of projects under (un)certainity – Project implementation procedure: Execution, measuring project progress, reporting project status, exercising management controls and user acceptance – Project planning and control techniques

UNIT V PROJECT MONITORING AND EVALUATION 8

Need and techniques for monitoring – Guide for successful project control – Different kinds of evaluation: Appraisal or ex-ante, on-going, mid-term, termination and ex-post evaluations – Evaluation criteria

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain about the project cycle, key elements in project formulation, methods and tools for project formulation
CO2 Independently execute the feasibility analysis of a project
CO3 Successfully assess the viability of a project in a more structured manner
CO4 Select appropriate funding sources and implement a project successfully
CO5 Explain about the techniques for effective monitoring and evaluation of a project

REFERENCES:

1. David I Cleland, Project Management: Strategic Design and Implementation, McGraw-Hill, India, 2007.
2. James P Lewis, Project Planning, Scheduling And Control, McGraw-Hill, India, 2001.
3. Stefano Gatti, Project Finance in Theory and Practice, Academic Press, UK, 2008.
4. Jack R Meredith, Samuel J Mantel, Project Management; A Managerial Approach, John Wiley and Sons, US, 2009.
5. Erik W Larson and Clifford F Gray, Project Management: The Managerial Process, McGraw-Hill, India, 2017.
6. Rashmi Agrawal and Yogieta S Mehra, Project Appraisal and Management, TAXMANN, India, 2021.

CO-PO MAPPING

1.	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	2	2
CO2	3	2	3	2	2	2
CO3	3	2	3	2	2	2
CO4	2	2	3	2	2	3
CO5	3	3	2	3	3	3
Avg	**3**	**2**	**3**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EN3014 ENVIRONMENTAL NANOTECHNOLOGY LT P C
3 0 0 3

UNIT I NANO-BASED MATERIAL AND THEIR SYNTHESIS 9

Defining nanotechnology - Properties of nanomaterial - Major applications in nanotechnology - Types of nanoparticles - Types and properties of engineered nanoparticles - Environmental applications of nanotechnology - General method of chemical synthesis - Biological synthesis of nanomaterial - Advanced synthesis methods – Natural nanomaterial – Development of nanocomposites

UNIT II CHARACTERIZATION TECHNIQUES 8

Scanning electron microscope analysis - Energy dispersive X-ray analysis - Transmission electron microscope analysis - Scanning tunneling microscopy - Atomic force microscopy - Raman spectroscopy - Ultraviolet-visible spectrometry - Fourier transform infrared spectroscopy - X-ray photoelectron spectroscopy - Dynamic light scattering - X-ray diffraction - Zeta potential

UNIT III NANO-BASED WASTE WATER TREATMENT TECHNOLOGY 10

Metal based nano-adsorbents - Carbon nanotubes adsorbents – Bio adsorbents (Membrane filtration) - Nanofiber membranes - Nanocomposite membranes - Nanomaterials in water treatment – Nano sorbents - Photocatalyst - Dendrimers in water treatment - Other nanomaterials in water purification - Nano-based sensing and monitoring systems - Case studies

UNIT IV NANO-BASED TECHNOLOGIES FOR SOIL REMEDIATION AND AIR PURIFICATION 9

Nanomaterials in soil remediation - Zero-valent iron nanoparticles - Carbon-based nanomaterials - Nanomaterials based on metals and oxides - Polymer based nanomaterials - Silica-based nanomaterials - Description of nano-based technology for soil remediation - Limitations on the use of nanostructured materials in soils - Nanotechnology in air pollution control - Case studies

UNIT V ETHICAL ISSUES OF NANOTECHNOLOGY 9

Life cycle assessment – Use and end of life effects (Emissions, fate and alterations) – Factors controlling the transport and ultimate fate of nanomaterials – Biodegradation – Contamination and risks – Exposure routes (Inhalation and potential toxicity) – Sustainable nanotechnology – Regulating nanomaterials

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain about the types, properties, application and synthesis of nanomaterials for environmental application

CO2 Independently execute the characterization of nanomaterials using advanced instruments

CO3 Successfully choose a viable nano-based option for water purification

CO4 Select appropriate nano-based technologies for contaminated site remediation and air purification

CO5 Explain about the risks, uncertainties and ethics of nanomaterials employed in environment sector

REFERENCES:

1. Lichtfouse E, Schwarzbauer J, Robert, D. Environmental Chemistry for a Sustainable World: Volume 1: Nanotechnology and Health Risk, Springer Science & Business Media, Germany, 2011.
2. Fulekar MH and Pathak B, Environmental nanotechnology, CRC Press, USA, 2017.
3. Marshall H, Environmental nanotechnology. Scientific e-Resources, India 2018.
4. Dasgupta N, Ranjan S, Lichtfouse E and Mishra BN, Environmental Nanotechnology, Springer International Publishing, UK, 2021.
5. Turan NB, Engin GO, Bilgili MS. Environmental Nanotechnology: Implications and Applications, Elsevier, Netherlands, 2022.

CO-PO MAPPING

1.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	3
CO2	3	2	3	2	2	2
CO3	2	2	2	2	3	2
CO4	3	2	3	2	2	3
CO5	3	2	3	2	2	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EM3252 SOLID AND HAZARDOUS WASTE MANAGEMENT L T P C
3 0 0 3

UNIT I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS 9

Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes,Plastic wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated solid waste management planning.

UNITII WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING 9

Waste sampling and characterization plan - waste generation rates and variation – physical composition, chemical and biological properties – hazardous characteristics – ignitability, corrosivity and TCLP tests –source reduction, segregation and onsite storage of wastes – waste exchange - extended producer responsibility - recycling of plastics, Micro plastics,C&D wastes and E wastes.

UNITIII WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY 9

Door to door collection of segregated solid wastes -analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes –- principles and design of transfer and transport facilities - hazardous waste transport and manifests - mechanical processing and material separation technologies – Size reduction – size separation - density separation - magnetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – E-waste kiosks - case studies on waste collection and material recovery

UNITIV BIOLOGICAL AND THERMAL PROCESSING OF WASTES 9

Biological and thermo chemical conversion technologies – composting – biomethanation – incineration – pyrolysis- plasma arc gasification –principles and design of biological and thermal treatment facilities - MSW processes to energy with high-value products and specialty BY-Products - operation of facilities and environmental controls - treatment of biomedical wastes – case studies and emerging waste processing technologies.

UNIT V WASTE DISPOSAL 9

Sanitary and secure landfills - components and configuration– site selection - liner and cover systems - geo synthetic clay liners and geo membranes - design of sanitary landfills and secure landfills-leachate collection, treatment and landfill gas management – landfill construction and operational controls - landfill closure and environmental monitoring – landfill bioreactors – rehabilitation of open dumps and biomining of dumpsites-remediation of contaminated sites- Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain the various functional elements of solid and hazardous waste management including the associated legal, health, safety, and culturalissues as well as responsibilities of different stakeholders

CO2 Apply the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes, assess thefactors affecting variation and assess performance of waste treatmentand disposal systems

CO3 Design of systems and processes to meet specified needs of waste minimization, storage, collection, transport, recycling, processing anddisposal.

CO4 Select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in asustainability context

CO5 Conduct research pertinent to solid and hazardous waste managementand communicate effectively to different stakeholders as well as engage in independent life-long learning

Attested

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. CPHEEO, “Manual on Municipal Solid waste management,Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Governmentof India, New Delhi, 2016.
3. William A. Worrell, P. Aarne Vesilind, Christian Ludwig, Solid Waste Engineering - A Global Perspective, 3rd Edition, Cengage Learning, 2017.
4. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York,2010.
5. John Pitchtel, Waste Management Practices, CRC Press,Taylor and Francis Group,2014.
6. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, Wiley, 2010
7. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018
8. Rao M.N, Razia Sultana, Sri Harsha Kota, solid and hazardous waste management –Science and Engineering , Butterworth-Heinemann, 2016

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	2
CO2	2	1	3	3	2	2
CO3	2	1	3	3	2	2
CO4	2	1	3	3	2	2
CO5	2	1	3	3	2	2
Avg	3	1	3	3	2	2

• 1-low, 2-medium, 3-high

EM3051 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING L T P C
3 0 0 3

UNIT I ENVIRONMENTAL MANAGEMENT STANDARDS 9

Unique Characteristics of Environmental Problems - Classification of Environmental Impact Reduction Efforts - Systems approach to Corporate environmental management - Business Charter for Sustainable Production and Consumption – Tools and Barriers - Evolution of Environmental Stewardship –National policies on abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking-UGC SATAT Framework

UNIT II PREVENTIVE ENVIRONMENTAL MANAGEMENT 9

Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification –Material balance – Technical, economic and environmental feasibility evaluation of Pollution Prevention options in selected industries –Preventive Environmental Management over Product cycle.

UNIT III ENVIRONMENTAL MANAGEMENT SYSTEM 9

ISO 14000 family- EMS as per ISO 14001– benefits and barriers of EMS – Understanding the organisation and its context- Understanding the needs and expectations of interested parties-

Determining the scope of the environmental management system- Leadership and commitment- Environmental policy- Organizational roles, responsibilities and authorities- Actions to address risks and opportunities- Environmental objectives and planning – Resources- Competence-Awareness- Communication-Documented Information –Operational Planning and Control- Emergency preparedness and response- Monitoring, measurement, analysis and evaluation - Management review- Life cycle Assessment -ecolabelling, ecological and carbon footprints.- Greenhouse gas accounting, Energy accounting

UNIT IV ENVIRONMENTAL AUDIT 9

Environmental management system audits as per ISO 19011-Internal Audits and Certification Audits – Principles of auditing- Roles and qualifications of auditors - Determining auditor competence- Managing an audit programme – Establishing and Implementing audit programme- Selecting audit team members and Assigning responsibility - Conducting an audit- opening meeting, Audit evidence gathering - Collecting and verifying information - Managing and maintaining audit programme records- closing meeting and reporting - Nonconformance – Corrective and preventive actions - Continual improvement - compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit - ISO 14064 & IS 50001

UNIT V CASE STUDIES 9

Case studies on applications of EMS, Life cycle Assessment, Waste Audits and Pollution Prevention in Textile industry , Tanning industry, Electroplating, Pulp & Paper, Dairy, Chemical industries and service organizations, automobile sector, cement industry, steel and aluminium manufacturing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain the various elements of Corporate Environmental Management systems and audits complying to international environmental management system standards

CO2 Apply the knowledge of science and engineering fundamentals to pollution prevention assessment and environmental performance evaluation

CO3 Develop environmental management systems for organisations

CO4 Conduct environmental management system audits taking into account the sustainability context

CO5 Conduct research pertinent to pollution prevention and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

1. ISO 14001/14004:2015 Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2015
2. ISO 19011: 2018, “Guidelines for auditing Management Systems, International Organisation for Standardisation, 2018
3. ISO 14031:2013, Environmental management -- Environmental performance evaluation Guidelines, International Organisation for Standardisation, 2021
4. ISO 14064-1:2018 – Greenhouse Gases – Part 1: Specification With Guidance At The Organization Level For Quantification And Reporting Of Greenhouse Gas Emissions And Removals,2018
5. ISO 14064-2:2019 – Greenhouse Gases – Part 2: Specification With Guidance At The Project Level For Quantification, Monitoring And Reporting Of Greenhouse Gas Emission Reductions Or Removal Enhancements , 2019
6. ISO 14064-2:2019 – Greenhouse Gases – Part 2: Specification With Guidance At The Project Level For Quantification, Monitoring And Reporting Of Greenhouse Gas Emission Reductions Or Removal Enhancements, 2019
7. ISO 14064-3:2019 – Greenhouse Gases – Part 3: Specification With Guidance For The Verification And Validation Of Greenhouse Gas Statements,2019
8. ISO 50001:2018 – Energy Management Systems Requirements with guidance for use.
9. Marek Bugdol and Piotr Jedynak, Integrated Management Systems, Springer International, 2015.
10. Ryan Dupont, Kumar Ganesan, Louis Theodore, Pollution Prevention: Sustainability, Industrial Ecology, and Green Engineering, Second Edition, CRC Press, 2016

11. Paul L Bishop 'Pollution Prevention: Fundamentals and Practice', McGraw- Hill International, Boston, 2004.
12. Lennart Nilsson, Per Olof Persson, Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene,Cleaner Production Technologies and Tools for Resource Efficient Production, The Baltic University Environmental Management book series, Uppsala 2007

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	2
CO2	2	1	3	3	2	2
CO3	2	1	3	3	2	2
CO4	2	1	3	3	2	2
CO5	2	1	3	3	2	2
Avg	**3**	**1**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

EM3052 OPERATION AND MAINTENANCE OF WATER AND WASTEWATER TREATMENT SYSTEMS **L T P C 3 0 0 3**

UNIT I ELEMENTS OF OPERATION AND MAINTENANCE 9

Strategy for good operation and maintenance- 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 – 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

UNIT II OPERATION AND MAINTENANCE OF WATER 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 incrustationand corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance ofwater pumps - problems in the water distribution system and remedies- water quality monitoring and surveillance

UNIT III OPERATION AND MAINTENANCE OF SEWERAGE SYSTEMS 9

Components and functions of sewerage system – 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 pumpingstations- maintenance hazards and operator protection –SOP-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 - chemicalmetering 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- SOP-case studies

UNIT V OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS 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 –planning, organizing and controllingof plant operations – capacity building, case studies of retrofitting- SOP-case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the O&M issues pertaining to STP and WTP
CO2 Understand operation and maintenance of water intakes and supply systems
CO3 Recognize the O&M issues relevant to sewerage system
CO4 Understand operation and maintenance of physico-chemical treatment units
CO5 Understand operation and maintenance of biological treatment units

REFERENCES:

1. CPHEEO, Manual on operation and maintenance of water supply systems, CentralPublic Health and Environmental Engineering Organisation, Ministry of Urban Development, Government of India 2013
2. Ministry of Drinking Water and Sanitation, operation and maintenance manual forrural water supplies, Government of India, 2013
3. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill,2017
4. Ananth S Kodavasal, The STP Guide-Design, Operation and maintenance, Karnataka State Pollution Control Board, Bangalore,2011
5. Frik Schutte, handbook for the operation of water Treatment Works,The Water Research Commission, The Water Institute of Southern Africa, TT265/06, 2006.
6. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.2 liquid process, 2007.
7. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.1 Management and support systems, sixth edition,2007.

CO-PO MAPPING

1.	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	3
CO2	3	3	2	2	3	2
CO3	2	2	2	2	2	2
CO4	2	3	3	2	2	2
CO5	3	2	2	3	3	3
Avg	**2**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

EM3053 CLIMATE CHANGE MODELLING, MITIGATION AND ADAPTATION **L T P C**
3 0 0 3

UNIT I GLOBAL WARMING AND CLIMATE CHANGE **9**

Climate system – Weather and climate - composition, classification - Milankovitch (Orbital) Cycles and their Role in Earth's Climate - Climate parameters - (Temperature, Rainfall, Humidity, Wind etc.,) – Green House effect and Climate change- Greenhouse gases and sources– Global warming and effects – Extreme weather events – Climate Change and Disasters - Sea level rise - Retreat of Glaciers – Thermohaline circulation –Global warming and ocean acidification –Ocean currents – Ekman Layers and the Ekman Spiral–El Nino – La Nina – causes, effects.- United Nations Framework Convention on Climate Change (UNFCCC), Conference of Parties (COPs) - International Agreements and protocols - Intergovernmental Panel on Climate Change (IPCC) -– IPCC Assessment Reports – Sixth Assessment Report

UNIT II CLIMATE CHANGE MODELLLING AND PROJECTIONS **9**

Climate change projection Scenarios and storylines –Representative Concentration Pathways and Shared Socio EconomicPathways (SSPs) - Salient features. - Modeling of the climate systems - Earths' energy budget – types, hierarchy and components of a climate model, Equations governing the atmosphere - Development of Climate models - General Circulation Models (GCMs) - Coupled Climate-Economy-Ecology-Biosphere Modeling - Issues with GCMs - Introduction to Regional

Climate Models (RCMs) and Limited Area Models (LAMs) - Downscaling of Global Climate Model –selection of GCMs for regional climate change studies – Ensemble theory - selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downscaling (Statistical and Dynamical) - Bias correction – Delta method, Quantile Mapping, Salient features and limitations, Model validation and calibration- evaluating model performance- post processing - Climate Projections for India and Tamil Nadu

UNIT III CLIMATE CHANGE IMPACTS AND ACTION FRAMEWORK 9

Climate Change Vulnerability and Risk assessment- Impact on Water Systems - Freshwater Resources - Ground water -Ocean and marine Resources - Agriculture and food security – Coastal and Terrestrial Ecosystems – Biodiversity and shift in major biomes - Forests – Health —Climate change impacts on vulnerable populations -Climate Equity and Environmental justice – Climate Action Framework – Parris agreement – NET Zero targets- Nationally determined Contributions – Climate Change Action Plan at national and State Level – National and State level Climate Change Missions and Action agenda

UNIT IV CLIMATE CHANGE MITIGATION 9

Established Technologies for Climate Change Mitigation- Energy Conservation, Efficiency, and Sustainable Energy Systems – Renewable energy systems – Solar energy systems – Wind energy systems – tidal and wave energy- Green Hydrogen –Biomass Energy- Energy Storage Challenges and Emerging options-Energy conservationin transportation and building – Alternative Energies – Carbon capture and storage – Chemical absorption – oxy –fuel combustion – Clean Coal Technology (CCT) – Carbon Sink estimation and Enhancement - Reducing Energy in Transport, Building, and Agriculture Through Social Efficiency – Co Benefits of Climate Change Mitigation – Carbon Markets –carbon Finance

UNIT V CLIMATE CHANGE ADAPTATION 9

Loss and Damages due to climate Change - Climate Change adaptation in agriculture sector - Climate resilient practices – Crop management – Drought tolerant crops, short duration crops, optimizing crop calendars, crop rotation - Water Resource management – Drip irrigation systems, programmed irrigation systems, small scale reservoirs – Site specific nutrient management – Livestock systems – Rotational grazing, Silvopastoral systems (Crop-livestock), Cut and carry fodder system, Manure Management –Forest management - Reforestation, regeneration and afforestation, Payments for ecosystem services(PES) – Nature based adaptive actions for Coastal ecosystems- Climate Resilient City Action Plan -Co Benefits of Climate Change Adaptation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1: Understand the basics of climate parameters and their effect on climate change and Comprehend the latest IPCC climate scenarios and International Agreements and Protocols

CO2: Understand the application of climate models and downscaling approach for future climate prediction

CO3: Gain thorough knowledge on how different sectors are affected by climate change and the action plans at National and State level

CO4: Gain in-depth knowledge on climate change mitigation measures

CO5: Understand the adaptive measures to be taken on different sectors to mitigate the climate change impacts

REFERENCES:

1. Maximilian Lackner, BaharakSajjadi and Wei-Yin Chen, Handbook of Climate Change Mitigation and Adaptation, Third Edition, Springer Nature, 2022.
2. IPCC Sixth Assessment Report, 2021.http://www.ipcc.ch/.
3. Tziperman, E. Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences, Princeton University Press, USA, P. 333. 2022.

4. Kendal McGuffie, Ann Henderson, “A Climate Modelling” Primer 4th Edition, John Wiley & Sons, Ltd, Chichester, UK 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	3	3
CO3	3	2	2	2	3	2
CO4	2	3	2	2	2	3
CO5	3	3	3	2	2	2
Avg	**3**	**3**	**2**	**2**	**3**	**2**

• 1-low, 2-medium, 3-high

EM3251 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance-EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process-screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Crosssectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 9

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – 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 SOCIO-ECONOMIC IMPACT ASSESSMENT 9

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment and Case Studies

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 multipathway exposure modeling of contaminant- Risk Characterization Risk communication

- Emergency Preparedness Plans –Design of risk management programs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles

CO2 Understand various impact identification methodologies, prediction techniques and model of impacts on various environments

CO3 Understand relationship between social impacts and change in community due to development activities and rehabilitation methods

CO4 Document the EIA findings and prepare environmental management and monitoring plan

CO5 Identify, predict and assess impacts of similar projects based on case studies

REFERENCES

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest andClimate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrentproblems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing andTransitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	-
CO2	1	1	1	2	2	3
CO3	1	1	1	1	1	1
CO4	-	2	2	1	3	1
CO5	1	2	3	2	3	3
Avg	**1**	**1**	**2**	**1**	**2**	**2**

• 1-low, 2-medium, 3-high