ANNA UNIVERSITY

NON-AUTONOMOUS COLLEGE

AFFILIATED TO ANNA UNIVERSITY

M.E. ENVIRONMENTAL ENGINEERING

REGULATIONS 2025

PROGRAMME OUTCOMES

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.

PROGRAMME SPECIFIC OUTCOMES

PSO	Programme Specific Outcomes
1	Apply advanced knowledge of environmental engineering principles, tools, and technologies to critically analyze, design, and manage systems for water, wastewater, air, and solid waste treatment.
2	Engage in research, innovation, and lifelong learning to develop and implement innovative solutions for environmental challenges, ensuring compliance with environmental policies, regulations, and societal needs.

ANNA UNIVERSITY, CHENNAI

POST GRADUATE CURRICULUM (NON.AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E., Environmental Engineering **Regulations:** 2025

Abbreviations:

BS – Basic Science (Mathematics)
ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**))
SD – Skill Development
SL – Self Learning

L – Laboratory Course
T – Theory

LIT – Laboratory Integrated Theory
PW – Project Work

TCP – Total Contact Period(s)

Semester I

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	EV25101	Environmental Statistics	T	3	0	0	3	3	ES (PC)
2.	EV25102	Environmental Chemistry	LIT	3	0	2	5	4	ES (PC)
3.	EV25103	Environmental Microbiology	LIT	3	0	2	5	4	ES (PC)
4.	EV25104	Physical and Chemical Treatment Systems for Water and Wastewater	T	3	0	0	3	3	ES (PC)
5.	EV25105	Solid and Hazardous Waste Management	T	3	0	0	3	3	ES (PC)
6.	EV25106	Technical Seminar	-	0	0	2	2	1	SD
						TOTAL	**21**	**18**	

Semester II

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	EV25201	Design of Biological Treatment systems	T	3	1	0	4	4	ES (PC)
2.	EV25202	Air and Noise Pollution Control Engineering	T	3	0	0	3	3	ES (PC)
3.	EV25203	Climate Change and Sustainability	T	3	0	0	3	3	ES (PC)
4.		Programme Elective I	T	3	0	0	3	3	ES (PE)
5.	EV25204	Environmental and Processes Monitoring Laboratory	L	0	0	4	4	2	ES (PC)
6.		Industry Oriented Course I	-	1	0	0	1	1	SD
7.		Self Learning Courses	-	-	-	-	-	1	SD
TOTAL							**18**	**17**	

Semester III

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Programme Elective II	T	3	0	0	3	3	ES (PE)
2.		Programme Elective III	T	3	0	0	3	3	ES (PE)
3.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
4.		Programme Elective V	T	3	0	0	3	3	ES (PE)
5.		Industry Oriented Course II	---	1	0	0	1	1	SD
6.	EV25301	Summer Internship	---	---	---	---	---	1	SD
7.	EV25302	Project Work I	---	0	0	12	12	6	SD
TOTAL							**25**	**20**	

Semester IV

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	EV25401	Project Work II	---	0	0	24	24	12	SD
TOTAL							**24**	**12**	

Programme Elective Courses [PE]

S. No.	Course Code	Course Title	Periods Per Week			Total Contact Periods	Credits
			L	T	P		
1.	EV25001	Natural Systems for Wastewater Treatment	3	0	0	3	3
2.	EV25002	Environmental System Analysis	3	0	0	3	3
3.	EV25003	Environmental and Sustainability Planning	3	0	0	3	3
4.	EV25004	Aquatic Ecosystem and Conservation	3	0	0	3	3
5.	EV25005	Environmental Impact Assessment	3	0	0	3	3
6.	EV25006	Septage and Onsite Wastewater Treatment Technologies	3	0	0	3	3
7.	EV25007	Project Formulation and Implementation	3	0	0	3	3
8.	EV25008	Soft Computing in Environmental Engineering	3	0	0	3	3
9.	EV25009	Design of Environmental Engineering Structures	3	0	0	3	3
10.	EV25010	Advanced Oxidation Process	3	0	0	3	3
11.	EV25011	Computing Techniques in Environmental Engineering	3	0	0	3	3
12.	EV25012	Geo Environmental Engineering	3	0	0	3	3
13.	EV25013	Environmental Monitoring Instruments	3	0	0	3	3
14.	EV25014	Environmental Nanotechnology	3	0	0	3	3
15.	EV25015	Water Quality Modeling	3	0	0	3	3
16.	EV25016	Marine Pollution and Control	3	0	0	3	3
17.	EV25017	Climate Change and Modeling	3	0	0	3	3
18.	EV25018	Operation and Maintenance of Water and Wastewater Treatment Systems	3	0	0	3	3
19.	EV25019	Artificial Intelligence in Environmental Reaction Engineering	3	0	0	3	3
20.	EV25020	Membrane Separation for Water and Wastewater Treatment	3	0	0	3	3
21.	EV25021	Air Quality Modeling	3	0	0	3	3
22.	EV25022	Emerging Contaminants and Remediation Technologies.	3	0	0	3	3

Semester I

EV25101	Environmental Statistics	L	T	P	C
		3	0	0	3

Course Objectives:

This course offers a comprehensive foundation in probability and statistical methods, specifically tailored for environmental engineering applications. Students will learn to model uncertainty using random variables and standard distributions. Key topics include correlation, regression, sampling, and hypothesis testing techniques. The course also emphasizes experimental design and variance analysis to enhance the interpretation of environmental data and experiments.

Probability Concepts and Standard Distributions: Probability concepts- Random variables, discrete and continuous; Probability Distributions- Binomial, Poisson, Geometric, Normal, Exponential, Probability distribution applications.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Sampling Distribution and Estimation: Introduction to sampling distributions, sampling distribution of mean and proportion, application of central limit theorem, sampling techniques. Estimation: Point and Interval estimates for population parameters of large sample and small samples, determining the sample size.

Activity: Assignment: Apply probability distribution to rainfall occurrence or flood frequency

Testing of Hypothesis: Hypothesis testing: one sample and two sample tests for means and proportions of large samples (z - test), one sample and two sample tests for means of small samples (t, test), F test for two sample standard deviations. ANOVA-one and two way.

Activity: Poster presentation

Correlation and Regression: Multiple and partial correlation, Method of least squares, Plane of regression, Properties of residuals, Coefficient of multiple correlation, Coefficient of partial correlation, Multiple correlation with total and partial correlations, Regression and partial correlations in terms of lower order coefficient.

Activity: Quiz on Correlation and Regression analyses

Applications and Case Studies: 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.

Activity: Case study presentation

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

References:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
2. Jay L. Devore, "Probability and statistics for Engineering and the Sciences", 8th Edition Cengage Learning, 2014.
3. Gupta. S.C and Kapoor, V.K,. "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand and Sons, New Delhi, 2020.
4. Ross, S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 6th Edition, Elsevier, 2020.
5. Spiegel M.R., Schiller J. and Srinivasan R.A., "Probability and Statistics", Schaum's Outline Series, Tata McGraw Hill, 4th Edition, 2012.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ma74/preview2
2. https://onlinecourses.nptel.ac.in/noc24_ma30/preview

	CO Description	PO Mapping	PSO1	PSO2
CO1	*Explain* probability concepts, random variables, and standard probability distributions and their applications in environmental and hydrological data.	-	-	-
CO2	*Apply* sampling distributions, estimation techniques, and hypothesis testing methods to analyze large and small sample data.	PO2 (2) PO3 (3)	3	1
CO3	A*nalyze* relationships among variables using correlation and regression techniques, and evaluate variability through ANOVA and F-tests.	PO1 (2) PO2 (1) PO3 (3)	3	2
CO4	*Interpret and evaluate* real-world case studies and time-series data to detect trends and seasonality in hydrological, meteorological, and water quality applications.	PO1 (2) PO2 (2) PO3 (2)	2	1

EV25102	Environmental Chemistry	L	T	P	C
		3	0	2	4

Course Objective:

This course educate the students in the area of water, air and soil chemistry. This course provides hands on experience to students in the analysis of physico-chemical parameters. The knowledge gained by the theoretical basis and observational methods used to analyses contaminants and interactions in the environment.

Fundamentals: Stoichiometry and mass balance, Chemical equilibria, acid base, solubility product, heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution, Ocean acidification, Chemical kinetics, Rate constant for First order and Second order Reactions, Problems, Effect of Temperature on Reaction Rates- 12 Principles of green chemistry.

Activity: Assignment

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

Practicals:

1. Sampling and Analysis of water Quality Parameters (i) pH (ii) Hardness (iii) Alkalinity (iv) Chloride (vi) Turbidity EC (Vii) TDS (viii) Iron ix) Heavy metals
2. Sampling and Waste water Analysis (i) Dissolved Oxygen (ii) COD (iii) Phosphate (iv) Oil & Grease(v) Surfactant (vi) Heavy metals

Atmospheric Chemistry: Atmospheric structure, chemical and photochemical reactions, photochemical smog. Ozone layer depletion, greenhouse gases and global warming, CO_2 capture and sequestration, acid rain, origin and composition of particulates. Black carbon, air quality parameters determination, Carbon Footprint & Carbon credit.

Activity: Quiz

Soil Chemistry: 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

Practical: Sampling and characterization of soil (Moisture, EC, pH, Na and K)

Emerging Pollutants: Heavy metals-chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals Pesticides, Dioxins & Furan, PCBs, PAHs and Fluoro compounds toxicity- Nano materials, CNT, titania, composites, environmental applications.

Activity: Case study on emerging pollutants

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (10%), Case Study (10%) Practical (30%), Internal Examinations (40%)

References:

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering
2. and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
3. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5thEdition,2012.
4. Manahan, S.E., "Environmental Chemistry", Ninth Edition, CRC press, 2009.
5. Ronald A. Hites,"Elements of Environmental Chemistry", Wiley, 2nd Edition,2012.

E-Resources

Web Content : Available in the NPTEL Course - Modules and Lectures - Environmental Chemistry and Analysis (Web) Syllabus Coordinated by IIT Madras

	CO Description	PO Mapping	PSO1	PSO2
CO1	*Explain* fundamental chemical principles (stoichiometry, equilibria, kinetics, green chemistry) and their relevance to environmental systems.	-	-	-
CO2	*Apply* concepts of aquatic, atmospheric, and soil chemistry to analyze pollutant behavior, transformations, and environmental impacts.	PO1 (2) PO3 (3)	2	1
CO3	*Analyze* emerging pollutants, their chemical speciation, and evaluate remediation strategies for environmental protection.	PO1 (2) PO3 (3)	3	2
CO4	P*erform and interpret* laboratory experiments on water, wastewater, and soil quality parameters, demonstrating quality control and environmental monitoring skills.	PO2 (2) PO3 (2)	2	1

EV25103	Environmental Microbiology	L	T	P	C
		3	0	2	4

Course Objective:

To provide the fundamentals of microorganisms, their diversity, metabolism, and ecological significance. The course further aims to apply microbial processes and toxicological principles for environmental monitoring, treatment, and sustainable management.

Microbial Fundamentals and Genetic Applications: Classification and types of microorganisms, Pathogens in water, soil, and air, Transmissible diseases – bacterial, viral, protozoan, helminthic; control and preservation techniques, DNA & RNA structure and replication – recombinant DNA technology, applications, and IPR in microbial research.

Activity: Quiz on Transmissible diseases

Microbial Diversity and Metabolism: Microbial distribution in ecosystems, Airborne microorganisms and aerosols – occurrence, health impacts, and biosafety protocols, Archaea in extreme environments and water supplies, Microorganisms in nutrient cycles: nitrogen, carbon, phosphorus, and sulphur, Nutritional requirements and microbial metabolism: carbohydrates, proteins, lipids, Microbial growth phases and influencing factors (pH, temperature, heavy metals), Pathways: glycolysis, TCA cycle, electron transport, oxidative phosphorylation, fermentation.

Practicals:

1. Preparation of culture media
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)

Environmental Applications of Microbes: Biodegradation and biotransformation of organic pollutants, Microbial processes in biological wastewater treatment: aerobic & anaerobic systems, Biochemical reactions: α-oxidation, β-oxidation, nitrification, denitrification, Nutrient removal: BOD, nitrogen, phosphorus, Sewage sludge microbiology, bioleaching applications, Indicator organisms: Total coliforms, E. coli, Streptococcus, Clostridium.

Practicals:

1. Measurement of growth of microorganisms
2. Analysis of air borne microorganisms

Environmental Toxicology and Emerging Pollutants: Principles of ecotoxicology – types of toxicants, acute & chronic effects, Test organisms, toxicity testing methods (lab & field), Bioaccumulation, biomagnification, bioconcentration, Bioassays and biomonitoring, Emerging pollutants: heavy metals (speciation of Hg & As), endocrine disruptors, pesticides, dioxins, furans, PCBs, PAHs, fluorinated compounds, Nanomaterials (CNT, titania, composites) – toxicity and environmental applications.

Practicals:

1. Effect of pH, temperature on microbial growth
2. Effect of Heavy metals on microbial growth

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (20%), Flipped Class (10%) Practical (30%) Internal Examinations (40%)

References

1. Ian L. Pepper, Charles P Gerba and Terry J Gentry, "Environmental Microbiology", 3rd Edition, Academic Press, 2015.
2. Gerard J Tortora, Berdell R Funke, Christine L Case, "Microbiology: An Introduction", 13th Edition, Pearson, 2019.
3. Bhatia S C, "Handbook of Environmental Microbiology", Vol I, II and III, Atlantic Publishers and Distributors, 2008.
4. Bruce Rittmann, Perry McCarty, "Environmental Biotechnology: Principles and Applications", 2nd Edition, McGraw Hill education, 2020.
5. Eugene L. Madson, "Environmental Microbiology: From Genomes to Biogeochemistry", Wiley–Blackwell, 2008

E-Resources:

https://onlinecourses.nptel.ac.in/noc25_ce05/preview

	CO Description	PO Mapping	PSO1	PSO2
CO1	E*xplain* microbial classification, structure, genetics, and diversity, along with their roles in ecosystems and human health.	-	-	-
CO2	*Apply* microbial techniques and biosafety protocols to study microbial metabolism, growth, and nutrient cycling in environmental systems.	PO1 (2) PO3 (3)	2	1
CO3	*Analyze* microbial processes in wastewater treatment, biodegradation, and biotransformation, and assess their environmental significance.	PO1 (2) PO3 (3)	3	1
CO4	*Evaluate and perform* toxicity testing, bioassays, and microbial experiments to assess pollutant impacts and propose	PO1 (1) PO2 (3) PO3 (2)	2	1

	CO Description	PO Mapping	PSO1	PSO2
	microbial-based solutions for environmental management.			

EV25104	Physical and Chemical Treatment Systems for Water and Wastewater	L	T	P	C
		3	0	0	3

Course Objective:

This course imparts comprehensive knowledge on the physical and chemical treatment processes essential for water and wastewater management. It emphasizes the design and application of treatment systems for municipal and industrial use while addressing emerging environmental challenges and sustainable practices.

Water and Wastewater Characteristics and Treatment Overview: Types and characteristics of pollutants in water and wastewater, Water quality standards and discharge norms, Importance of physico-chemical treatment methods, election criteria for treatment methods, Overview of reactor types (batch, continuous), Kinetics of reactor operations.

Physical Treatment Processes: Screening, mixing, equalization, Sedimentation and filtration (gravity and pressure filters), Evaporation and incineration, Gas transfer and mass transfer coefficients, Membrane separation processes: Reverse osmosis, nanofiltration, ultrafiltration, electrodialysis, Distillation, stripping, crystallization.

Activity: Quiz on Physical treatment processes

Chemical Treatment Processes: Coagulation, flocculation, and precipitation, Flotation, disinfection methods (chlorination, ozonation, UV), Ion exchange and electrolytic methods, Solvent extraction, Advanced oxidation and reduction processes, Solidification and stabilization techniques, Recent advances in chemical treatment.

Activity: Poster presentation on chemical treatment processes

Design of Water Treatment Plants: Design of municipal water treatment Modules: aerators, dosing systems, flocculators, clarifiers, filters (RSF, SSF, dual media), Disinfection Modules, flow charts, hydraulic profiles, Design of industrial water treatment: softeners, demineralizers, RO systems, P&ID, construction and O&M considerations, Residue management and plant retrofitting.

Activity: Problem-solving exercises on sedimentation, filtration, and coagulation design calculations.

Design of Wastewater Treatment Plants: Design of municipal wastewater Modules: screens, grit chambers, sedimentation tanks, Sludge management: thickening, dewatering, drying beds, Design of industrial wastewater Modules: equalization, neutralization, flotation Modules, chemical feed systems, oil skimmers, Hydraulic profiles, layouts, P&ID, Residue handling, plant upgradation, recent trends in wastewater treatment

Activity: Field visit to nearby Water and Wastewater Treatment plants.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Field visit report & Poster presentation (10%), Quiz (10%), Assignment (10%), Practical (30%), Internal Examinations (40%)

References

1. Metcalf & Eddy. (2021). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
2. Qasim, S. R. (2000). *Water works engineering: Planning, design and operation* (1st ed.). Prentice Hall.
3. Spellman, F. R. (2021). *Handbook of water and wastewater treatment plant operations* (4th ed.). CRC Press.
4. Qasim, S. R., & Zhu, G. (2018). *Wastewater treatment and reuse* (1st ed.). Taylor & Francis.
5. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2013). *Manual on sewerage and sewage treatment – Part A, B, C*. Ministry of Housing and Urban Affairs, Government of India.
6. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2019). *Manual on water supply and treatment* (4th ed.). Ministry of Housing and Urban Affairs, Government of India.

E-Resources

- NPTEL Course on Environmental Engineering: https://nptel.ac.in/courses/105105045
- Coursera – Water Treatment Fundamentals: https://www.coursera.org/learn/water-treatment
- USEPA Water Research Portal: https://www.epa.gov/water-research
- MOOC on Wastewater Treatment – edX: https://www.edx.org/course/wastewater-treatment

	CO Description	PO Mapping	PSO1	PSO2
CO1	*Identify* the types, characteristics, and standards of water and wastewater pollutants.	PO2 (2) PO3 (3)	1	2
CO2	*Apply* principles of physical and chemical treatment methods for pollutant removal.	PO1 (2) PO2 (3) PO3 (2)	2	2
CO3	*Analyze* and *design* municipal and industrial water/wastewater treatment units, including hydraulic profiles and P&IDs.	PO1 (2) PO2 (3) PO3 (3)	2	3

	CO Description	PO Mapping	PSO1	PSO2
CO4	*Evaluate* treatment technologies and recent advances for sustainable water and wastewater management.	PO1 (2) PO2 (1) PO3 (2)	2	3

EV25105	Solid and Hazardous Waste Management	L	T	P	C
		3	0	2	4

Course Objective:

To provide advanced knowledge on the characterization, collection, transport, treatment, and disposal of solid and hazardous wastes, and to develop sustainable strategies and design solutions for effective waste minimization, resource recovery, and environmental protection.

Fundamentals of Solid Waste Management: Sources and types of solid waste – industrial, municipal, agricultural, biomedical, e-waste, and construction debris, Waste characterization – physical, chemical, and biological properties, Generation rates, composition, and influencing factors, Environmental and health impacts of improper solid waste management, Regulatory framework: Solid Waste Management Rules (SWM Rules, 2016 and amendments).

Collection, Transportation, and Processing of Solid Waste: Waste collection methods, collection efficiency, route optimization, Transfer stations – design and operation, Processing techniques – mechanical volume reduction, shredding, compaction, Resource recovery: segregation at source, material recovery facilities (MRFs).

Activity: Case studies on urban solid waste collection and processing systems.

Treatment and Disposal of Solid Waste: Composting, vermicomposting, anaerobic digestion, biogas recovery, Incineration: design, operation, and emission control, Pyrolysis and gasification – principles and applications, Sanitary landfill design, leachate management, and landfill gas control, Integrated solid waste management (ISWM) approach.

Activity: Site visit to any of the waste management practices

Hazardous Waste Management: Definition, classification, and characteristics of hazardous waste, Sources and impacts of hazardous waste (industrial, biomedical, nuclear, e-waste), Hazardous waste regulations: Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, Hazardous waste treatment: physico-chemical, biological, thermal, and stabilization methods, Hazardous waste disposal: secured landfills, deep well injection, encapsulation.

Activity: Quiz on Hazardous Waste Management

Sustainable and Emerging Approaches: Waste-to-energy technologies and their applications in India, Life Cycle Assessment (LCA) for solid and hazardous waste systems, Circular economy concepts: recycling, recovery, reuse, Zero waste approaches and sustainable urban waste management

Activity: Poster presentation on Successful SWM and hazardous waste management projects (national and international).

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (15%), Case Study report (15%), Internal Examinations (40%)

References:

1. George Tchobanoglous, Hilary Theisen, and Samuel Vigil – *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw-Hill, Latest Edition.
2. Ramesha Chandrappa and Dasappa Umesh – *Solid Waste Management: Principles and Practice*, Springer, 2012.
3. M. D. LaGrega, P. L. Buckingham, and J. C. Evans – *Hazardous Waste Management*, McGraw-Hill, Latest Edition.
4. Frank Kreith and George Tchobanoglous (Eds.) – *Handbook of Solid Waste Management*, McGraw-Hill, 2nd Edition.
5. Christoph Scharff and David Wilson – *Waste Management: Planning, Policy and Practice*, Routledge.

E-Resources

1. UNEP – International Environmental Technology Centre (IETC) https://www.unep.org/ietc
2. U.S. Environmental Protection Agency (EPA) – Waste Management https://www.epa.gov/hw
3. SWANA (Solid Waste Association of North America) Learning Center https://swana.org

	CO Description	PO Mapping	PSO1	PSO2
CO1	Analyze the sources, composition, and characteristics of solid and hazardous wastes, and evaluate their environmental impacts.	PO1 (2) PO3 (3)	2	1
CO2	Apply principles of collection, transportation, processing, and treatment techniques for effective solid waste management.	PO1 (2) PO3 (3)	3	2
CO3	Design and evaluate solid and hazardous waste treatment and disposal systems, including landfills and waste-to-energy technologies.	PO1 (2) PO3 (2)	2	2
CO4	Assess regulatory frameworks, sustainable practices, and emerging approaches for integrated waste management.	PO2 (2) PO3 (2)	2	2

Semester II

EV25201	Design of Biological Treatment Systems	L	T	P	C
		3	1	0	4

Course Objective:

This course introduces the principles and kinetics involved in biological wastewater treatment and provides in-depth knowledge on the design of aerobic and anaerobic systems. It equips students with the skills to plan, operate, and troubleshoot treatment systems, focusing on sludge management and emerging treatment technologies.

Reaction Kinetics and Bioreactors

- Objectives of biological treatment – significance
- Principles of aerobic and anaerobic treatment
- Kinetics of biological growth – factors affecting growth
- Attached and suspended growth – kinetic coefficients – enzyme kinetics
- Biodegradability assessment – batch/CSTR/PFR reactors
- Flow charts, layouts, P&ID, hydraulic profile

Activity: Seminar, Quiz

Conventional Aerobic Treatment Processes

- Design of STP Modules – activated sludge process and modifications
- Trickling filters, RBC, fluidized beds, lagoons, ponds
- Constructed wetlands – nutrient removal – reclamation, reuse

Activity: Poster presentation

Advanced Aerobic Treatment Processes

- SBR, MBBR, MBR – design and applications
- Membrane separation for reuse – nutrient removal – tertiary treatment
- Case studies

Activity: Flipped Class Room

Anaerobic Treatment Processes

- UASB, anaerobic filters, baffled reactors, expanded/fluidized bed reactors
- Post-treatment, nutrient removal, anammox, septic tanks

Activity: Reproduction of research paper

Sludge Treatment and O&M

- Sludge sources and characteristics
- Sludge digestion, dewatering, biogas recovery
- Residue disposal, O&M issues, retrofitting, capacity building

Activity: Industrial/Field visit

References

1. Arceivala, S.J. &Asolekar, S.R., Wastewater Treatment for Pollution Control and Reuse, 3rd Edition (reprint July 2017), McGraw-Hill Education, 2007.
2. Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, McGraw-Hill Education, 2021.
3. Qasim, S.R., and Zhu, Guang, Wastewater Treatment and Reuse, 1st Edition, Taylor & Francis, 2018.
4. Davis, Mackenzie L., Water and Wastewater Engineering: Design Principles and Practice, 2nd Edition, McGraw-Hill Education, 2020,
5. Frank R. Spellman, Handbook of Water and Wastewater Treatment Plant Operations, 4th Edition, CRC Press, 2021.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the principles of biological kinetics and the functioning of aerobic and anaerobic treatment processes.	-	-	-
CO2	Evaluate and compare conventional and advanced biological treatment systems for wastewater management.	PO1 (2) PO3 (3)	3	2
CO3	Design key components of aerobic and anaerobic treatment units, including bioreactors and sludge handling systems.	PO1 (3) PO3 (2)	3	2
CO4	Interpret process flow diagrams, P&IDs, and performance data to assess operational efficiency and troubleshoot treatment systems.	PO1 (2) PO2 (3) PO3 (2)	2	3

EV25202	Air and Noise Pollution Control Engineering	L	T	P	C
		3	0	0	3

Course Objective:

This course provides a comprehensive understanding of air and noise pollution, including their sources, impacts, and relevant scientific and regulatory frameworks. It also equips students with the skills to evaluate and devise appropriate solutions for air and noise pollution challenges.

Fundamentals of Air Pollution

Structure and classification of the atmosphere - Atmospheric chemistry - Sources and classification of air pollutants - Effects of air pollutants on human health and the environment - Air quality standards and legislation: Ambient air quality standards (NAAQS, WHO), emission standards, emission inventory - Overview of the Air (Prevention and Control of Pollution) Act – Major global air pollution events.

Activity: Case Study Presentation on major global air pollution disasters

Air Pollution Monitoring and Modelling

Source sampling and emissions measurement techniques: high-volume samplers, gas analyzers - Analysis of particulate and gaseous pollutants - Air quality index (AQI) – concepts and computation - Stack plume pattern - transport and dispersion of air pollutants – Fundamentals of air pollution modeling and prediction- modelling techniques.

Activity: Field Visit to a Continuous Ambient Air Quality Monitoring Station (CAAQMS)

Control of Particulate Pollutants

Engineering concepts for particulate emissions control – Factors affecting selection of control equipment – Working principle, design and performance equations of gravity separators, cyclones, Fabric filters, particulate scrubbers, electrostatic precipitators – operational considerations - costing of APC equipment

Control of Gaseous Pollutants

Principles and methods for controlling gaseous emissions - working principle, design and performance equations of absorption, adsorption, condensation, incineration, bio-scrubbers, bio-filters – control technologies- SO_2, NOx CO, H_2S; process control and monitoring - operational considerations - costing of APC equipment – emerging trends.

Activity: Research Paper Reproduction on biofilters or advanced gas control technologies.

Noise Pollution and Control

Sources and effects of noise pollution – Noise measurement tools and techniques – Noise prediction and modeling tools – Control at source, transmission path, and receiver end – Regulatory framework: CPCB norms and ISO/OSHA standards - Case studies on commModuley noise management and industrial noise abatement.

Activity: Quiz on CPCB and OSHA noise standards.

References:

1. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 2019
2. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2010.
3. Wayne T. Davis, Joshua S. Fu, and Thad Godish, Air Quality CRC press, Newyork, 2021
4. Enda Murphy, Eoin A. King, Environmental Noise Pollution: Noise Mapping, Public
5. Health, and Policy, 2022, First Edition, Elsevier's Science & Technology, USA. Air (Prevention and Control of Pollution) Act, India, 1981

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Field visit report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the fundamentals of air pollution, including atmospheric structure, pollutant characteristics, health impacts, and regulatory standards.	-	-	-
CO2	Apply appropriate air pollution monitoring, sampling, and modelling techniques to assess ambient and source emissions.	PO1 (3) PO3 (2)	3	2
CO3	Analyze and evaluate the performance, selection criteria, and design parameters of particulate and gaseous emission control systems.	PO1 (3) PO3 (2)	3	2
CO4	Assess noise pollution levels and propose suitable control strategies based on regulatory frameworks and prediction tools.	PO1 (2) PO2 (2) PO3 (2)	2	3

EV25203	Climate Change and Sustainability	L	T	P	C
		3	0	0	3

Course Objective:

To impart advanced knowledge of climate system science and sustainability frameworks, and to equip students with analytical tools for climate modeling, impact assessment, and evaluation of mitigation and adaptation strategies.

Climate System Science & Climate Change Fundamentals

Earth's energy balance and greenhouse effect - Greenhouse gases and atmospheric processes - Carbon cycle and climate feedback - Climate sensitivity and tipping points -Paleoclimate evidence and observed trends - Natural variability vs anthropogenic forcing

Activity: Poster presentation on Climate system components and feedback loops

Climate Modeling, Impacts & Risk Assessment

Climate model hierarchy: EBM, GCM, ESM (overview) - Emission scenarios: RCPs and SSPs - Downscaling concepts and uncertainty - Climate extremes and attribution science - Impacts on water, agriculture, ecosystems - Urban and infrastructure climate risks

Activity: Case study on Flood and heat risk assessment for an Indian city

Sustainability Science & Climate Mitigation

Sustainability paradigms (strong vs weak sustainability) - Planetary boundaries and SDGs - Life Cycle Assessment (LCA – principles & applications) - Energy systems and decarbonization pathways - Carbon pricing, ETS, and mitigation economics - Low-carbon and negative-emission technologies

Activity: Numerical exercise on Marginal abatement cost concept

Climate Adaptation, Policy & Governance

Climate adaptation and resilience concepts - Climate-resilient infrastructure and urban systems - Nature-based solutions - Global climate governance (UNFCCC, Paris Agreement) - India's climate policy: NDCs, NAPCC - Climate finance, ESG, and infrastructure case studies - Metro rail and sustainable urban transport

Activity: Quiz on Adaptation strategies for urban infrastructure

References:

1. **Smil, V.**, *Energy and Civilization: A History*, MIT Press, Cambridge, USA.
2. **Stern, N.**, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, UK.
3. **UNEP**, *Emissions Gap Report*, United Nations Environment Programme, Nairobi.
4. **World Bank**, *Climate Change Knowledge Portal and Climate Risk Country Profiles*, World Bank Publications.

E- Resources

IPCC (Intergovernmental Panel on Climate Change) – Assessment Reports & summaries
https://www.ipcc.ch
UNFCCC (United Nations Framework Convention on Climate Change) – Climate agreements & NDCs, https://unfccc.int
UNEP (United Nations Environment Programme) – Emissions Gap Reports & sustainability insights, https://www.unep.org
World Bank – Climate Change Knowledge Portal – Country climate risk & data https://climateknowledgeportal.worldbank.org

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Field visit report (20%), Internal Examinations (40%)

	CO Description	**PO Mapping**	**PSO1**	**PSO2**
CO1	Explain climate system dynamics and observed changes	-	-	-
CO2	Interpret climate projections and assess impacts.	PO1 (3) PO3 (2)	3	1
CO3	Apply sustainability frameworks and mitigation tools	PO1 (3) PO2 (3)	2	3
CO4	Analyze adaptation strategies and climate policy instruments	PO1 (3) PO3 (2)	3	2

EV25204	Environmental and Processes Monitoring Laboratory	L	T	P	C
		0	0	4	2

Course Objective:

This laboratory course aims to provide hands-on experience in analyzing and monitoring physical, chemical, and biological treatment processes in water and wastewater systems. It enables students to understand process kinetics, reactor performance, and critical parameters governing treatment efficiency. The course also familiarizes students with ambient air and noise monitoring techniques, equipping them with practical skills essential for environmental quality assessment and compliance.

Physico-Chemical Water Treatment Processes

Mandated Activities:

- Conduct coagulation and flocculation tests to evaluate turbidity removal.
- Perform settling and filtration studies to determine critical design parameters.
- Assess water softening efficiency through chemical dosing.
- Evaluate disinfection efficiency using chlorination residuals.

Experiments Covered:

1. Coagulation and Flocculation
2. Batch Studies on Settling
3. Studies on Filtration – Characteristics of Filter Media
4. Water Softening
5. Disinfection for Drinking Water (Chlorination)

Advanced Water Quality Engineering

Mandated Activities:

- Investigate adsorption kinetics and isotherms using activated carbon.
- Perform Langelier and Silt Density Index tests for membrane fouling prediction.
- Demonstrate photocatalytic degradation of organic pollutants under UV light**.**

Experiments Covered:

6. Adsorption Studies / Kinetics
7. Langelier Saturation Index and Silt Density Index
8. Advanced Oxidation Processes – Photocatalysis

Biological Treatment Systems

Mandated Activities:

- Study growth kinetics and substrate removal using the activated sludge process.
- Determine sludge volume index and filterability for sludge dewaterability analysis.
- Observe and record performance of anaerobic reactors (demo-based).

Experiments Covered:

9. Kinetics of Suspended Growth Process (Activated Sludge) and SVI
10. Sludge Filterability Test
11. Anaerobic Reactor Systems / Kinetics (Demonstration)

Environmental Monitoring (Air and Noise)

Mandated Activities:

- Operate air sampling instruments to measure PM_{10}, $PM_{2.5}$, SO_2, and NO_2 levels.

- Carry out noise level assessments using sound level meters and compute Leq values.

Experiments Covered:

12. Ambient Air Sampling – Determination of PM_{10}, $PM_{2.5}$, SO_2, and NO_2
13. Noise Monitoring – Determination of Equivalent Noise Level.

References

1. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton, H. David Stensel, *Wastewater Engineering: Treatment and Resource Recovery*, 5th Edition, McGraw-Hill Higher Education, 2014.
2. Lee, C. C. & Shun-Dar Lin, *Handbook of Environmental Engineering Calculations*, McGraw-Hill, New York, 1999.
3. Association of Environmental Engineering and Science Professors Foundation, *AEESP Environmental Engineering Processes Laboratory Manual*, AEESP, 2001 (CD version; awaiting updated edition).
4. Aery, N. C., *Manual of Environmental Analysis*, Ane Books Pvt. Ltd., New Delhi, 2014.
5. Central Pollution Control Board, Ministry of Environment, Forests & Climate Change, *Technical Guidelines/SOPs for Measurement of Ambient Air Pollutants, Volume I*, CPCB, Revised February 7, 2025.

E- Resources

NPTEL – Wastewater Treatment (Kinetics, ASP, Anaerobic reactors) https://nptel.ac.in/courses/105105048

Other MOOC / Web Resources

1. USEPA – Drinking Water Treatment Process Simulation Tool https://www.epa.gov/water-research/drinking-water-treatment-plant-simulation
2. CPCB India – Ambient Air Quality Monitoring Guidelines https://cpcb.nic.in/ambient-air-quality-monitoring/
3. WHO – Water Sanitation and Health (WSH) Technical Guidelines https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Apply physico-chemical, biological, and advanced water/air quality analysis techniques to evaluate treatment efficiency and environmental quality.	PO1 (2) PO2 (1) PO3 (2)	3	2
CO2	Analyze experimental data from treatment and monitoring systems to interpret process performance, operational behaviour, and compliance with standards.	PO1 (3) PO2 (2) PO3 (3)	3	3

PROGRAMME ELECTIVE COURSES

EV25001	Natural Systems for Wastewater Treatment	L	T	P	C
		3	0	0	3

Course Objective:

This course offers essential knowledge on natural and constructed wetlands for treating domestic and industrial wastewaters, focusing on design, treatment processes, and case studies. It also covers the design and operation of waste stabilization ponds and effective sludge management.

Introduction to Wetland Treatment System

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.

Activity: Case review on health impacts and on-site applications of wetlands.

Constructed Wetland and Removal Mechanisms

Site identification- construction and design of constructed wetland, 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 and pathogen. Reuse of treated wastewater and its applications, limitation of constructed wetland system.

Activity: Mini-experiment on media filtration (sand/gravels) and pollutant removal demonstration.

Case Studies on Constructed Wetland System

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.

Activity: Individual presentation on real-world CW applications

Design of Wastewater Pond Systems

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.

Activity: Design exercise: facultative pond / aerated pond sizing.

Sludge Management and Treatment

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

Activity: Assignment: onsite wastewater disposal and reuse plan for a small community.

References

1. EPA- Design Manual on constructed wetland and aquatic plant system for municipal wastewater treatment system
2. Natural Wastewater Treatment Systems, Ronald W. Crites, E. Joe Middlebrooks, Robert K.Bastia, 2nd Edition, CRC PressPublished March 14, 2014
3. Waste water treatment in constructed wetlands with horizontal sub- surface flow by Jan Vyamazal and Lenka Kropfelova, Springer 2010.
4. Constructed wetlands for industrial wastewater treatment system by Alexandros I.Stefanakis (editor), Wiley black well.2018
5. https://onlinecourses.nptel.ac.in/noc21_ce25/preview

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the principles, types, and ecological functions of natural and constructed wetlands used in wastewater treatment.	-	-	-
CO2	**Apply** hydrological, hydraulic, and pollutant removal concepts to analyze the performance of constructed wetlands and pond systems.	PO1 (3) PO2 (1) PO3 (3)	3	2
CO3	**Analyze** case studies and design data to evaluate treatment efficiency, sludge management options, and reuse potential.	PO1 (3) PO2 (2) PO3 (3)	3	3

EV25002	Environmental System Analysis	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce fundamental and advanced modeling techniques applied to environmental systems including ecological, reactor, and water quality modeling.
- To equip students with the ability to analyze microbial dynamics, perform system simulations, and apply numerical and optimization techniques using computational tools.
- To expose students to current trends such as soft computing, AI/ML integration, and cloud-based modeling for sustainable environmental system analysis.

Ecological System

Basic concepts in ecology and ecological modeling. Population dynamics: birth and death processes; single species growth. Prey–predator models: Lotka–Volterra, Rosenzweig–MacArthur, Kolmogorov models. Multi-species modeling: structural analysis and stability of complex ecosystems. Ecoinformatics and ecological data integration.

Activity: Quiz on population dynamics and multi-species interactions

Reactor Modelling

Modeling of reactors: Continuous Stirred Tank Reactor (CSTR), plug-flow, and dispersion systems. Case study of a tubular reactor with axial dispersion. Parameter calibration using search algorithms for nonlinear dynamical models; analysis of variance of estimated parameters. Applications to Monod and Haldane kinetics. Computational sustainability in reactor design and optimization. Real-time uncertainty and sensitivity analysis.

Activity: Case study on Tubular reactor with axial dispersion.

Water Quality Modelling

Modeling of water quality in rivers and streams – dispersion and mixing processes. Framework for water quality modeling: model sensitivity analysis and performance assessment. Models for dissolved oxygen (DO), pathogens, and nutrient dynamics. Groundwater quality modeling. Application of AI/ML and soft computing techniques in water quality prediction.

Activity: Poster presentation on application of AI/ML in water quality prediction

Microbial Dynamics and Energetics

Carbon and nutrient removal requirements in biological systems. Activated sludge process schemes: completely mixed, plug-flow, Sequential Batch Reactor (SBR), and nutrient removal systems. Anaerobic digestion: process dynamics and operational control. Microbial modeling using metagenomics. Hybrid modeling frameworks for large-scale treatment systems.

Activity: Assignment on Interpretation of metagenomic datasets for microbial community analysis.

Computer-Based Solutions

Formulation and solution of linear optimization models; linear programming fundamentals; sensitivity analysis and duality. Application of programming tools for system modeling, parameter estimation, and experimental design. Cloud-based environmental simulations and big data integration. Hybrid modelling. IoT-based monitoring and control systems.

Activity: Quiz.

References

1. Deaton, M. L. &Winebrake, J. J. *Dynamic Modeling of Environmental Systems* (with CD-ROM and STELLA), Springer-Verlag, 2000.
2. Orhon, D. & Artan, N. *Modeling of Activated Sludge Systems*, Technomic, 1994.
3. Chapra, S. C. *Surface Water–Quality Modeling*, 2008 reprint, Waveland Press.
4. Reichert, P. & van Rolleghem, P. (eds.) – *River Water Quality Model No.1 (RWQM1)* (various editions).
5. Henze, M. et al. – *Activated Sludge Model Framework* (ASM1–3), IWA Publishing.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Analyze ecological, reactor, and water quality systems using mathematical and computational models.	PO1 (3) PO3 (3)	3	2
CO2	Apply hydrodynamic, kinetic, and microbial process concepts to simulate pollutant transformation and treatment performance.	PO1 (3) PO3 (2)	3	2
CO3	Evaluate and develop integrated computational and hybrid modeling frameworks for environmental systems, including optimization and data-driven decision-making.	PO1 (3) PO3 (2) PO3 (2)	3	3

EV25003	Environmental and Sustainability Planning	L	T	P	C
		3	0	0	3

Course Objective:

To provide students with a comprehensive understanding of sustainable development principles and the evolving role of planners in addressing environmental challenges. It introduces key concepts such as land use planning, climate resilience, environmental justice, and sustainable infrastructure through theoretical and policy-based frameworks. Students will gain insights into global and national planning mechanisms that promote equity, resilience, and ecological integrity in the context of sustainability.

Foundations of Environmental and Sustainability Planning

Evolution and scope of environmental planning - Sustainability - definitions, dimensions and principles (environmental, social, economic) - Planner's role, ethics, and responsibility in sustainability - Global sustainability frameworks - UNSDGs and indicators, IPCC pathways, planetary boundaries - Systems thinking and resilience theory - Anthropocene concept and sustainability challenges.

Activity: Quiz on sustainability principles and frameworks

Land Use, Ecosystems, and Resource-Based Planning

Land suitability analysis and conservation zoning - Landscape ecology - Carrying capacity - Smart growth, form-based codes, LEED-ND, and TOD principles - Greenfield and brownfield development strategies - Biodiversity and ecosystem services integration in planning.

Activity: Field visit / virtual tour of a brownfield redevelopment

Climate Change, Risk and Resilience Planning

Urban vulnerability - Climate science integration into planning (IPCC, NAPAs) - Adaptation and mitigation strategies - Climate-resilient infrastructure and nature-based solutions - Carbon budgeting - GHG Audits - Risk and vulnerability assessments (e.g., SoVI) - Disaster preparedness and resilience indicators - Climate gentrification and managed retreat strategies.

Activity: Poster presentation on Disaster preparedness and resilience indicators

Environmental Justice, Law, and Governance

Environmental justice - Concepts, procedural and substantive equity - Environmental Impact Assessment and Strategic Environmental Assessment - Environment (Protection) Act 1986, Air (Prevention and Control of Pollution) Act 1981, Water (Prevention and Control of Pollution) Act 1974, EIA 2006 - Multilevel governance - national, state, local frameworks - Public participation tools - Digital platforms for public participation.

Sustainable Infrastructure and Planning Tools

Urban metabolism and circular economy concepts - Infrastructure planning across water, waste, and energy sectors - Green infrastructure and integrated nexus approaches –

Planning Tools - GIS, Urban Footprint, LEAP, WEAP, GHG audit software - Sustainability metrics, benchmarking, and indicators - Sustainable Procurement and Life Cycle Assessment - Net Zero Planning Frameworks - C40 toolkit - Case studies

Activity: Case study on circular economy in urban infrastructure

References:

1. John Randolph, "Environmental Land Use Planning and Management", 2nd Edition, Island Press, 2011.
2. Thomas Elmqvist, Xuemei Bai, Niki Frantzeskaki Corrie Griffith, David Maddox, Timon Mcphearson, Susan Parnell, Patricia Romero Lankao, David Simon, Mark Watkins, "Urban Planet: Knowledge towards Sustainable Cities", Cambridge University Press, 2021.
3. Ayyoob Sharifi, Amir Reza Khavarian-Garmsir, "Urban Climate Adaptation and Mitigation" 1st Edition, Elsevier, 2022.
4. Barry E. Hill, "Environmental Justice: Legal Theory and Practice", 5th Edition, Environmental Law Institute, 2023.
5. Bradley Striebig, Adebayo A. Ogundipe, Maria Papadakis, Lauren G. Heine, "Environmental Engineering and Sustainable Design", 2nd Edition, Cengage Learning, 2023.

Online Resources:

https://onlinecourses.nptel.ac.in/noc25_de04/preview
https://onlinecourses.nptel.ac.in/noc25_mg124/preview

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain principles, frameworks, and tools for sustainable environmental and urban planning.	-	-	-
CO2	Apply planning, assessment, and modeling tools to analyze urban sustainability and infrastructure systems.	PO1 (3) PO2 (2) PO3 (3)	3	2
CO3	Analyze case studies and policy frameworks to assess environmental justice, resilience, and sustainability performance in urban systems.	PO1 (3) PO2 (2) PO3 (3)	3	3

EV25004	Aquatic ecosystem and conservation	L	T	P	C
		3	0	0	3

Course Objective:

This course explores the structure and function of aquatic ecosystems, including freshwater and marine habitats. It examines human impacts on biodiversity, productivity, and nutrient cycling. Conservation strategies and relevant legal frameworks for sustainable management are also addressed.

Fundamentals of Aquatic Ecosystems

Classification: Freshwater (lentic and lotic systems)-estuarine and marine ecosystems-Physical and chemical properties of water Hydrological cycle and watershed characteristics
Energy flow and trophic structure Ecological niches, food webs, and commModuley dynamics in aquatic habitats.

Activity: Field/virtual visit to a river, lake, or estuary to observe ecosystem structure

Biological Components nd Biodiversity

Aquatic flora and fauna: plankton, nekton- benthos,-periphyton Biodiversity indices and species richness Indicator species and keystone species Wetland ecology and Ramsar sites
Invasive species and their impacts on native biodiversity.

Activity: Case study presentation on invasive species and wetland conservation

Water Quality, Pollution and Anthropogenic Stressors

Sources and types of aquatic pollution: point and non-point Nutrient enrichment and eutrophication Thermal, heavy metal, and organic pollution Bioaccumulation and biomagnifications Water quality parameters and indices (DO, BOD, COD, pH, EC, etc.) Case studies of impacted rivers, lakes, and coastal waters in India

Conservation, Restoration and Management Strategies

Principles of conservation biology-Wetland and riparian zone restoration techniques-Lake rejuvenation and riverfront development –Bio manipulation and constructed wetlands-Integrated watershed management -Role of NGOs and commModuley participation in conservation.

Activity: Poster presentation on community-based conservation strategies

Policies, Legislations, and Global Perspectives

National Water Policy, Wetlands (Conservation and Management) Rules -Biodiversity Act, Water (Prevention and Control of Pollution) Act -River Action Plans (e.g., Ganga and Yamuna) -International conventions: Ramsar, CBD, SDGs (Goal 6, 14, and 15)-Institutional frameworks: CPCB, SPCBs, MoEFCC, UNEP-Emerging tools: Environmental DNA (eDNA), remote sensing, GIS

Activity: Quiz

References

1. Goldman, C.R. & Horne, A.J. (1983) Limnology, 2nd Edition, McGraw-Hill International.
2. Wetzel, R.G. (2001) Limnology: Lake and River Ecosystems, 3rd Edition, Academic Press.
3. Moss, B. (2009) Ecology of Freshwaters: A View for the Twenty-First Century, 4th Edition, Wiley-Blackwell.
4. Gopal, B. (2017) Aquatic Ecosystems: Trends and Global Prospects, CRC Press.
5. Chapman, D. (Ed.) (1996)Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring, 2nd edition,UNESCO/WHO/UNEP

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the structure, function, and biodiversity of aquatic ecosystems, including ecological niches and trophic dynamics.	-	-	-
CO2	Apply water quality assessment methods and pollution analysis to evaluate the health of aquatic ecosystems.	PO1 (3) PO2 (2) PO3 (2)	3	2
CO3	Analyze conservation, restoration, and policy strategies to design sustainable management plans for aquatic ecosystems.	PO1 (3) PO2 (2) PO3 (2)	3	2

EV25005	Environmental Impact Assessment	L	T	P	C
		3	0	0	3

Course Objective:

This course aims to introduce the principles, process, and legal framework of Environmental Impact Assessment (EIA) to ensure sustainable project planning and development. It equips students with the necessary tools and methodologies to assess environmental, socio-economic, and risk-related impacts of various projects, enabling informed decision-making and effective environmental management.

Introduction to Environmental Impact Assessment

Evolution and need of Environmental Impact Assessment (EIA) – Role of EIA in project planning and clearance – Legal and regulatory frameworks in India – Types, significance, and limitations of EIA – EIA process: screening, scoping, Terms of Reference (ToR), impact analysis, and mitigation – Cross-sectoral linkages, public consultation, and role of accredited EIA consultants – Introduction to Strategic Environmental Assessment (SEA).

Activity: Quiz on EIA types, ToR, and legal frameworks

Environmental Impact Identification and Prediction

Methods for impact identification: matrices, networks, and checklists – Analysis of alternatives and cost-benefit analysis in EIA – Use of expert systems and GIS in EIA – Tools and techniques for impact prediction – Mathematical models for air, water, soil, noise, and biological impact assessment – Cumulative Impact Assessment (CIA) – Climate impact and disaster risk assessment in EIA.

Activity: Case study: cumulative and climate impact assessment

Socio-Economic Impact Assessment

Concept and importance of socio-economic impact assessment (SEIA) – Relationship between social impacts, commModuley dynamics, and institutional changes – Key factors influencing SEIA and assessment methodologies – Impacts at individual, family, and commModuley levels – Social equity and vulnerability considerations – CommModuley displacement, resettlement, and rehabilitation strategies.

Activity: Poster presentation on social impacts of a local project

Environmental Management Plan

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

Environmental Risk Assessment and Management

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.Field Visit to near byIndustires.

Activity: Field visit to a nearby industry for practical observation.

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 and Climate Change, Government of India
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
4. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012
5. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.

E-Resources

1. https://archive.nptel.ac.in/courses/124/107/124107160/
2. https://archive.nptel.ac.in/courses/120/108/120108004/

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the principles, processes, and legal frameworks of EIA, SEA, and environmental risk assessment.	-	-	-
CO2	Apply impact identification, prediction, and socio-economic assessment techniques using GIS, modeling tools, and expert systems.	PO1 (3) PO2 (2) PO3 (2)	3	2
CO3	Analyze case studies and prepare Environmental Management Plans and risk management programs for sustainable project planning.	PO1 (3) PO2 (2) PO3 (2)	3	3

EV25006	Septage and Onsite Wastewater Treatment Technologies	L	T	P	C
		3	0	0	3

Course Objective:

- To understand on the principles and process designs aspects of onsite sanitation and decentralized wastewater management systems.
- To gain competency in the process employed in sludge and septate management systems and the components comprising such systems, leading to the selection of specific process.

Urbanization and Sanitation

Sanitation Infrastructure in Urban India - Emerging Recognition of Faecal Sludge and Septage Management -Sanitation Service Chain -Faecal Sludge and Septage -Need for Faecal Sludge and Septage Management -Septage Management and Sewerage Systems -Components of Sanitation Value Chain- Approach to Septage Management in Cities

Activity: Poster presentation on sanitation challenges in Indian cities

Desludging and Conveyance Of Septage

Planning for Emptying Services - Current Status of Emptying Services -Need for Periodic Cleaning of Septic Tanks - Prohibition of Employment as Manual Scavengers and their Rehabilitation Act- Technologies for Desludging - Parameters for Assessing Conveyance Options - Demand Based Desludging - Schedule Based Desludging - Private Sector Participation.

Activity: Site visit to a septic tank emptying or desludging operation

Sewage Treatment

Unit Operations and Processes – Selection of treatment processes — Onsite sanitation – Septic tank- Grey water harvesting- Decentralized sewage treatment – Design of septic tank with depression pit – DEWATS, Intermittent sand filters – Anaerobic filters – Waste stabilization ponds – Design and operation.

Activity: Case study on decentralized sewage treatment in urban areas

Sludge Stabilization

Objectives-Aerobic and Anaerobic Sludge digestion processes – Types of anaerobic digesters – design of Low rate and High rate digesters – Two stage digester-Aerobic digestion- Pure oxygen and thermopilic aerobic digestion - Chemical and Thermal stabilization process.

Activity: Quiz on design and operational parameters of different digesters

Reuse and Land Application Of Sewage Sludge

Introduction- beneficial use-requirements and associated risks-handling and management-storage - operation aspects of transport and application of biosolids application land- Lagooning- Landfilling-land farming-Composting-windrow composting -Vermicomposting -Laws and regulations on sludge management.

References

1. Manual for “Sewerage and Sewage Treatment Systems” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. Metcalf & Eddy, INC, Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
3. Septage management in urban India, National Urban Sanitation policy, Ministry of Urban Development Government of India, 2013.
4. National Policy on Faecal Sludge and Septage Management (FSSM) Ministry of Urban Development Government of India, 2017.

E-resources

1 .https://archive.nptel.ac.in/courses/124/107/124107160/
2. https://archive.nptel.ac.in/courses/120/108/120108004/

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study/field visit report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain urban sanitation infrastructure, FSSM, and the principles of desludging and conveyance of septage.	-	-	-
CO2	Apply treatment, stabilization, and decentralized systems design concepts for sewage and sludge management.	PO1 (3) PO2 (2) PO3 (2)	3	2
CO3	Analyze and evaluate reuse options, land application strategies, and regulatory compliance for sludge management.	PO1 (3) PO2 (2) PO3 (2)	3	3

EV25007	Project Formulation and Implementation	L	T	P	C
		3	0	0	3

Course Objective:

It provides students with a comprehensive understanding of project lifecycle management, covering traditional screening techniques, ideation facilitated by AI and blockchain technology, and proposal development. Using integrated assessment frameworks like climate resilience valuation, drone-based EIA, BIM costing, and AI risk modelling, students can learn about decision-making for sustainable infrastructure. This course provides how to manage projects from start to finish using digital financing tools. IoT-enabled progress monitoring and blockchain-verified impact assessment.

Introduction to Project Formulation

Project Formulation Principles-Concept, need, and significance of project formulation-Project lifecycle phases and cycle management -Traditional methods for idea search and screening – Recent Approaches and frame works - AI-assisted project identification-Digital citizen engagement-ESG-aligned screening -Blockchain-verified project selection-Digital twin prototyping for rapid validation -Proposal preparation with integrated capital accounting.

Activity: Group exercise on idea screening for environmental projects

Project Feasibility Analysis

Project Feasibility assessment-Technical, economic, legal, operational, and scheduling Demand forecasting techniques-Project cost determination and profitability estimation-Integrated Analysis Systems-BIM-integrated costing-Drone-based EIA surveys-AI assisted forecasting- Project valuation-Carbon footprint monetization in cash flows-Automated EIA using AI Integrated GIS-Digital currency-backed cost tracking models.

Activity: Case study analysis for project feasibility

Project Appraisal

Project Appraisal Fundamentals-Technical, financial, institutional, commercial, and environmental appraisal-NPV, IRR, BCR calculations-Social cost-benefit analysis frameworks -Contemporary Risk Management-Monte Carlo cloud simulations-Gender-responsive budgeting tools -Project Appraisal Valuation Systems-Climate stress testing (RCP 8.5) -Natural capital valuation (TEEB Framework)-AI-Assisted credit scoring.

Activity: Quiz

Project Financing and Implementation

Project Financing Fundamentals-Project financing stages: Pre-financing-Financing-Post-financing-Sponsor/funding agency typologies-Tender procedures (Transparency Act compliance)-Implementation Frameworks-CPM/PERT networks for planning-Resource and risk management protocols-Green bonds certification-Digital Execution

Systems-GeM 4.0 e-procurement platforms-IoT-based progress monitoring-Smart contract management.

Activity: Assignment on the Design a project implementation schedule using CPM/PERT

Project Monitoring and Evaluation

Project Monitoring Systems-Service level benchmarks and schedules-Ex-ante, ongoing, mid-term, ex-post evaluations-Penalty-bonus systems design.Digital Monitoring Technologies-IoT-enabled SLA tracking (STP efficiency sensors)-Satellite based progress verification-Advanced Verification Systems-Blockchain-audited impact reporting-AI sentiment analysis for feedback-Smart contract penalties.

Activity: Group exercise on blockchain-audited impact reporting

References:

1. Cleland, D.I. & Ireland, L.R., *Project Management: Strategic Design and Implementation*, 5th ed., McGraw-Hill, 2022.
2. Agrawal, R. & Mehra, Y.S., *Sustainable Project Appraisal and Management*, Taxmann, 2024.
3. Gatti, S., *Green Project Finance: Theory and Practice*, 4th ed., Academic Press, 2023.
4. Silvius, G. & Schipper, R., *Digital Transformation in Project Management*, Routledge, 2024.
5. Tapscott, D. & Tapscott, A., *Blockchain Revolution for Infrastructure Projects*, MIT Press, 2023.
6. National Institute of Urban Affairs, *Smart Project Implementation Handbook*, NIUA, 2024.
7. Eastman, C. et al., *BIM for Sustainable Infrastructure*, 3rd ed., Wiley, 2023.
8. UNEP, *Natural Capital Valuation Guidebook*, Moduleed Nations, 2023.

E-Resources

9. "Digital Governance of Public Projects" [Video Course], NPTEL (IIT Delhi), 2024. [Online]. Available: https://nptel.ac.in/courses/107108201
10. "AI for Infrastructure Monitoring" [Video Course], NPTEL (IIT Bombay), 2024. [Online]. Available: https://nptel.ac.in/courses/107107185

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain principles, lifecycle, and methods of project formulation, appraisal, and financing in environmental projects.	-	-	-
CO2	Apply feasibility analysis, cost estimation, appraisal tools, and digital technologies for planning and implementing environmental projects.	PO1 (3) PO2 (2) PO3 (2)	3	2
CO3	Analyze project risks, monitoring, and evaluation strategies, integrating AI, IoT, GIS, and blockchain for sustainable project management.	PO1 (3) PO2 (2) PO3 (2)	3	3

EV25008	Soft Computing in Environmental Engineering	L	T	P	C
		3	0	0	3

Course Objective:

Students who finish this course will be able to create and use cutting-edge computational intelligence solutions to solve tough environmental problems. Using data science workflows and soft computing techniques, students learn how to model, analyze, and improve environmental systems of different sizes. Using industry-standard tools, students will learn how to use cloud-native analytics pipelines and decision frameworks that take uncertainty into account.

Soft Computing Principles

Introduction to soft computing techniques –Paradigms - ANN, Fuzzy Logic, Evolutionary computation, Hybrid systems vs traditional computation -Algorithm design and Flow charts. Numerical Methods-Finite Difference (FDM), Finite Element (FEM), Finite Volume (FVM) methods- Radial Basis Functions for irregular state analysis- Lattice Boltzmann Methods (LBM) for complex flows-Physics-informed neural networks (PINNs) for Environmental data fusion. Introduction to Environmental modelling-temporal, spatial scale analysis, model development, calibration, uncertainty and sensitivity. Digital Twins.

Activity: Case study on digital twin application in water or air quality modeling

Deep Learning And Evolutionary Computation

Artificial Neural Networks-Algorithms -Supervised, Unsupervised – Deep learning-Multilayer Perceptron's, (MLPs), Back propagation, regularization and Convolutional Neural Networks (CNNs) - Recurrent Neural Networks (RNNs/LSTMs/GRUs), Graph Neural Networks for temporal data, Evolutionary and Swarm Intelligence - Genetic Algorithms (GAs) for Multi-objective Optimization (NSGA-II, SPEA2), Particle Swarm Optimization (PSO), Ant Colony Optimization. Federated Learning for IoT data. blockchain and Quantum annealing.

Fuzzy Logic in Environmental Engineering

Fuzzy logic Fundamentals – Fuzzy sets vs. crisp sets, membership functions-operations and inference system. Probability -Dempster-Shafer Theory- rough sets. Hybrid system-Fuzzy Cognitive Maps (FCMs) for complex causal modelling, Hybrid Neuro-Fuzzy Systems (ANFIS), Probability Fuzzy fusion.

Environmental Data Science and Analytics

Environmental data types -time series, geospatial, imagery, spectral, categorical, sensor streams/IoT - Data base Management-Different Architectures - Data lakes, cloud databases (SQL/ PostgreSQL/Postages, MongoDB, Timescale DB), data versioning. Handling missing data, outliers, noise, inconsistencies. Temporal/spatial alignment, Exploratory Data Analysis (EDA) - time series decomposition, spatial autocorrelation (Moran's I). Advanced regression (LASSO, Ridge, GAMs), classification (SVM, Random Forests, XG Boost), clustering, factor analysis, goodness-of-fit metrics.Big

Data challenges, crowdsourcing. Big Data Analytics: Distributed computing frameworks (Apache Spark, Disk), parallel processing.Leveraging Cloud Platforms for scalable storage and computation and deployment. Introduction to Geospatial Cloud (Google Earth Engine, Microsoft Planetary Computer).

Activity: Poster presentation on Classification/regression modeling for air/water quality prediction

Environmental Modeling Software

Basic of Programming – Python: libraries -NumPy, SciPy, Pandas,Geopandas, Rasterio, GDAL/OGR,Matplotlib, Seaborn, Plotly, Folium,Scikit-learn, TensorFlow/PyTorch,DEAP, SciKit-Fuzzy). R for statistics (Tidyverse, terra/sf and Julia . Introduction to MATLAB, COMSOL, Wolfram Mathematica, Maple Software- Tool boxes and applications in environmental engineering, Introduction to geospatial data analysis- QGIS with Whitebox tools, ArcGIS with extensions, GRASS. Environmental Data interoperability. Pollutants transport, decay and degradation modelling using MIKE SHE,SWAT+,Open AQ, Dagster/Prefect.

Activity: Quiz

References:

1. Aliev R.A. and Aliev Rashad, "Soft Computing and its Applications", World Scientific Publishing Co., Singapore, 2021.
2. Roy Samir and Chakraborty Udit, "Soft Computing: Neuro-Fuzzy and Genetic Algorithms", Pearson India Education Services, 2022.
3. Chapra Steven C. and Canale Raymond P., "Numerical Methods for Engineers", 8th Edition, McGraw-Hill, New York, 2022.
4. Solomatine Dimitri P. and Ostfeld Avi, "Data-Driven Modeling for Water Resources and Environmental Engineering using Python", Springer, 2023.
5. Camps-Valls Gustau et al., "Deep Learning for the Earth Sciences", Wiley, 2021.
6. Sivanandam S.N. and Sumathi S., "Fuzzy Logic Engineering with MATLAB®", 2nd Edition, McGraw-Hill, 2022.
7. Deb Kalyanmoy, "Multi-Objective Optimization Using Evolutionary Algorithms", 2nd Edition, Wiley, 2023.

E-Learning Resources

1. "Artificial Intelligence: Knowledge Representation and Reasoning" [Video Course], NPTEL (IIT Delhi), 2023. [Online]. Available: https://nptel.ac.in/courses/106105182
2. "Introduction to Machine Learning" [Video Course], NPTEL (IIT Madras), 2023. [Online]. Available: https://nptel.ac.in/courses/106106226.
3. "Computational Hydrology" [Video Course], NPTEL (IIT Roorkee), 2023. [Online]. Available: https://nptel.ac.in/courses/105108077

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study/field visit report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the principles of soft computing, fuzzy logic, and environmental data modeling.	-	-	-
CO2	Apply deep learning, evolutionary computation, and data analytics techniques to environmental datasets.	PO1 (3) PO2 (2) PO3 (2)	3	2
CO3	Analyze and evaluate environmental systems and modeling results using hybrid soft computing and geospatial tools.	PO1 (3) PO2 (3) PO3 (2)	3	2

EV25009	Design of Environmental Engineering Structures	L	T	P	C
		3	0	0	3

Course Objective:

To equip students with the fundamental principles and design methodologies for key environmental engineering structures of water and wastewater treatment plants and to develop the ability to integrate environmental, hydraulic, and structural considerations in the planning and design of infrastructure in the treatment Modules.

Introduction to Design Concepts and Design of Pipes

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. Pipes for environmental engineering structures-Structural design of- Concrete, Prestressed Concrete, Steel and Cast-iron piping mains - anchorage for pipes- massive outfalls.

Activity-Quiz.

Design of Water Retaining Structures

IS Codes for the design of water retaining structures- Design of concrete roofing systems Design of circular, rectangular tanks, and spherical tanks- Design of prestressed concrete cylindrical tank, Clariflocculators, Filtration Modules.

Activity- industrial/field visit.

Design of Wastewater Retaining Structures

Structural design of wastewater treatment Modules- Grit chamber, Parshall flume, Aeration tank, Anaerobic baffle reactor (ABR), Upflow Anaerobic Sludge Blanket Reactor (UASBR), Sludge digester, Sludge thickener, Sludge drying beds.

Design of Storage Structures

Design of square bunker and storage structures– IS codal provisions– Design of cylindrical silo. Foundation design of water tanks, bunkers, and silo - isolated, combined and raft foundation. Activity- model making.

Special Structures

Design of masonry walls, pillars, and footings as per NBC and IS Codes-Structural design of underground reservoirs, Intake towers- effect of earth pressure and uplift considerations– design of cyclone separator– Scrubber, Fundamental engineered landfill structures and components.

Activity- poster presentation.

References:

1. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, New Delhi, 6th Edition, 2016.
2. Ramaswamy, G.S., “Design and Construction of Concrete shell roofs", CBS Publishers, India, 2nd (enlarged) Edition, 2005.
3. John P. Forth and Andrew J. Martin, Design of Liquid Retaining Concrete Structures, 3rd Edition, Whittles Publishing, 2014.
4. Rajagopalan K., "Storage structures", Tata McGraw Hill, New Delhi, 1998.
5. Metcalf & Eddy – “Wastewater Engineering: Treatment and Resource Recovery” McGraw-Hill Education, 5th Edition, 2014

E-Resources:

1. Design of water retaining structures - IS 3370, specifically Parts 1, 2, and 3.
2. Design of pipes in water and wastewater treatment Modules - IS 1172:1993 and IS 7232:1974 for basic requirements of water supply, drainage, sanitation and biological treatment processes.
3. www.torch-air.com/blog/wet-cyclone-scrubber
4. https://archive.nptel.ac.in/content/storage2/courses/103103027/pdf/mod5.pdf

www.researchgate.net/publication/307436757_Landfill_Design_and_Operation

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain fundamental design concepts, limit state philosophy, and IS code provisions for environmental engineering structures.	-	-	-
CO2	Apply structural design principles to pipes, water and wastewater retaining structures, and storage units using standard codes.	PO1 (3) PO2 (3) PO3 (2)	3	2
CO3	Analyze and evaluate specialized environmental engineering structures such as scrubbers, cyclone separators, and landfill components for safety and performance.	PO1 (3) PO2 (3) PO3 (2)	3	3

EV25010	Advanced Oxidation Process	L	T	P	C
		3	0	0	3

Course Objective:

To provide a comprehensive understanding of fundamentals of Advanced Oxidation Process.

To develop the ability to critically evaluate and design AOP-based treatment systems.

Introduction to AOPs

Fundamentals of Advanced Oxidation Process (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.

Activity: Poster presentation

Homogenous AOPs

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.

Activity: Quiz

Heterogeneous AOPs

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 – Physio chemical methods for characterization of Nano materials.

AOP Enhancement Techniques

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 – Hybrid AOPs.

Activity: Case study

Industrial Applications And Economic Assessment of AOPs

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

Activity: Assignment

References:

1. Maulin P. Shah, Sweta Parimita Bera, Gunay Yildiz Tore, “Advanced Oxidation Processes for Wastewater Treatment – An Innovative 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.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the principles, mechanisms, and types of advanced oxidation processes (AOPs) for water and wastewater treatment.	-	-	-
CO2	Apply homogeneous, heterogeneous, and enhanced AOP techniques to design and evaluate oxidation processes for contaminant removal.	PO1 (3) PO2 (3) PO3 (2)	3	3
CO3	Analyze industrial applications and perform economic assessment of AOP systems for water and wastewater treatment.	PO1 (3) PO2 (3) PO3 (2)	3	3

EV25011	Computing Techniques in Environmental Engineering	L	T	P	C
		3	0	0	3

Course Objective:

To facilitate the students to learn about the soft computing techniques used in environmental engineering, and to explain the artificial intelligence like ANN, Fuzzy logic, and genetic algorithm applications in environmental engineering along with data management and the corresponding modelling software.

Soft Computing Principles

Introduction to computing techniques – principles - algorithms and flowcharts, numerical methods - solution to ordinary and partial differential equation using finite difference, finite element and finite volume methods, numerical integration, and differentiation, digital models for environmental applications.

Activity-Quiz

Artificial Intelligence

Knowledge based expert system concepts - principle of Artificial Neural Network (ANN) – perceptron learning rule, neural network structure – neural network operations – ANN Algorithm - Application of ANN Model to environmental field – genetic algorithms (GA) – case study.

Activity- Seminar/Poster presentation

Fuzzy Logic

Fuzzy logic principles – elements - fuzzy logic and the theory of uncertainty - fuzzy set theory- fuzzy membership function, fuzzy relations, fuzzy rule, and applications of the fuzzy set theory to inference and control, clustering, and image processing – case study.

Activity- Case study

Digital Data Management

Data base structure - data acquisition - data warehouse - DBMS - RDBMS - data analysis - network data sharing - Statistical Analysis (SYSTAT) - regression - factor analysis - histogram - scatter diagram - goodness of fit – big data analysis – GIS – environmental spatial data management.

Environmental Modeling Software

Introduction to MATLAB Software – MATLAB applications in environmental studies– pollutants transport, decay and degradation modelling - MIKE 21 – MODFLOW, water quality models- QUAL2K -WASP,air quality models-AERMOD – CALPUFF - case studies.

Mandated activity-Project based learning.

References

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

E-Resources:

1. NPTEL course on Fuzzy Sets, Logic and Systems & Applications by Prof. Nishchal Kumar Verma, IIT Kanpur
2. https://link.springer.com/book/10.1007/978-3-031-05767-0
3. https://www.taylorfrancis.com/books/edit/10.1201/9781003605553/computational-techniques-environmental-engineering-akhilesh-kumar-yadav

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain principles of soft computing, artificial intelligence, fuzzy logic, and environmental data management for modeling applications.	-	-	-
CO2	Apply ANN, GA, fuzzy logic, and database management techniques to environmental modeling and data analysis problems.	PO1 (2) PO2 (3) PO3 (2)	3	2
CO3	Analyze environmental processes and model outputs using software tools like MATLAB, MIKE 21, MODFLOW, QUAL2K, and air quality models for decision support.	PO1 (2) PO2 (3) PO3 (2)	3	2

EV25012	Geo Environmental Engineering	L	T	P	C
		3	0	0	3

Course Objective:

- To gain comprehensive knowledge of geotechnical engineering issues related to soil contamination, including causes, assessment methods, and remediation techniques.
- To safe disposal of waste and remediate the contaminated soils by different techniques
- To remediate the contaminated ground water thereby protecting environment.

Introduction

Waste management Hierarchy- Concepts of Integrated SWM - Geo-Environmental Engineering problems types – Inorganic and organic toxic chemicals, composition of soils, soil properties, inorganic and organic geochemistry – Landfills: Components - Legal framework for landfilling – Landfill siting considerations; Leachate – Landfill water balance - Hydrologic Evaluation of Landfill Performance (HELP) model.

Activity: Quiz

Contaminant Transport and Fate

Transport processes, chemical mass transfer processes, biological processes, contaminant transport and fate modeling, landfill and surface impoundments, in-situ barriers, ground water contamination.

Activity: Poster presentation

Subsurface Contamination and Waste Containment

Sources and types of contamination, remediation approach, contaminated site characterization, risk assessment and remedial strategy. Vertical and bottom barriers, surface caps, ground water pumping systems, subsurface drains, liner systems.

Activity: Assignment

Soil Remediation

Soil vapour extraction, soil washing, stabilization and solidification, Electrokinetic Remediation, Thermal desorption, Vitrification, Bioremediation, Phytoremediation, Soil fracturing.

Activity: Case study

Ground Water Remediation

Pump and treat, In-situ flushing, permeable reactive barriers, in-situ air sparing monitored natural attenuation, bioremediation.

References

1. Sharma H.D. and Reddy K.R., "Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley& Sons, Inc., USA, 2004.
2. Yong, R. N., "Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation" CRC Press, New York, 2001.

3. Reddi L.N. and Inyang, H. I., "Geoenvironmental Engineering, Principles and Applications" Marcel DekkerInc. New York, 2000.
4. Tchobanoglous, G., Solid waste management. Environmental engineering: environmental health and safety for municipal infrastructure, land use and planning, and industry. Wiley, New Jersey, pp.177-307, 2009
5. Townsend, T.G.; Powell, J.; Jain, P.; Xu, Q.; Tolaymat, T.; Reinhart, D., Sustainable practices for landfill design and operation. Springer, 2015.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ce03/preview
2. http://digimat.in/nptel/courses/video/105102160/L03.html
3. https://onlinecourses.nptel.ac.in/noc19_ce37/preview

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain principles of integrated solid waste management, contaminant transport, and subsurface contamination in soils and groundwater.	-	-	-
CO2	Apply landfill design, containment systems, and soil/groundwater remediation techniques to practical geotechnical and environmental problems.	PO1 (3) PO2 (3) PO3 (2)	3	2
CO3	Analyze contaminant fate, assess risks, and evaluate the effectiveness of remediation strategies using modeling and field data.	PO1 (3) PO2 (3) PO3 (2)	3	2

EV25013	Environmental Monitoring Instruments	L	T	P	C
		3	0	0	3

Course Objective:

To provide students with a strong foundation in environmental sampling techniques, analytical instrumentation, and data interpretation. The course aims to equip learners with the skills to accurately monitor, quantify, and analyze pollutants in air, water, and soil for informed environmental assessment and decision-making.

Introduction

Types of Sampling and Their Methods – Methods of Air, Water, Soil Sampling – Sampling Protocols & Selection of Sites – Time and Frequency for Sampling – Preservation – Storage and Handling of Samples.

Activity: Field visit to collect air, water, and soil samples using standard protocols

Fundamentals of Analytical Data and Instrumentation

Data in Quantitative Analysis – Accuracy, precision, standard deviation – Types of errors, minimization of error, significant figure – Criteria for rejection of data – Principles of instrumentation – Selection of method.

Activity: Problem-solving session on selecting appropriate analytical methods for different environmental matrices.

Instrumental Methods

Electromagnetic radiation, matter radiation interactions – Colorimetry and spectrophotometry, fluorimetry, nephelometry and turbidimetry, flame photometry, Colorimetry (principle, working and uses) – Atomic Absorption Spectrometry, Atomic Emission Spectrometry – Mass spectrometry, principles and applications.

Activity: Case study on real-world applications of mass spectrometry in environmental analysis.

Electrochemical Methods

Principles, applications, usages, limitations, electrochemical method – Pulse polarography, cyclic voltammetry, anode stripping voltammetry, electrophoresis – Principles of Neutron Activation Analysis, Principles of X-ray Fluorescence (XRF), X-ray Diffraction (XRD), applications.

Activity: Quiz on electrochemical methods.

Chromatography Methods

Classification of chromatographic techniques – Principles, applications, advantage, limitations of following chromatographic methods – Thin layer chromatography – Paper chromatography – Gas chromatography – Ion exchange chromatography – Size exclusion chromatography – Affinity chromatography.

References

1. Environmental Sampling and Analysis for Technicians; M. Csuros, Lewis Publishers, Boca Raton, 1994.

2. Instrumental Methods of analysis, Willard H H& Dean LL, John Willey, 2016.
3. Modern Methods of chemical analysis Recsok RL, & Shields LD, John Willey & sons, Inc 2020.
4. Instrumental Methods of chemical analysis, Ewing GW, McGrw Hill Book Company, Inc.2015.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain principles of environmental sampling, data accuracy, and fundamental analytical and instrumental methods.	-	-	-
CO2	Apply appropriate sampling protocols and instrumental/analytical techniques for the detection and quantification of environmental pollutants.	PO1 (2) PO2 (3) PO3 (2)	3	2
CO3	Analyze and interpret analytical data from electrochemical, spectroscopic, and chromatographic methods to assess environmental quality.	PO1 (2) PO2 (3) PO3 (2)	3	2

EV25014	Environmental Nanotechnology	L	T	P	C
		3	0	0	3

Course Objective:

To introduce the basic science and engineering concepts of nanoscience and nanotechnology. To get an insight of nano material for utilization in environmental conservation. To integrate theoretical knowledge use of nanotechnology in environmental remediation. Evaluate mechanisms that define nanomaterial fate and transport, nanomaterial toxicity, and ecological effects in natural and engineered environments.

Introduction to Environmental Nanotechnology - Nanomaterial for environmental protection and their synthesis -Physico - chemical approaches - Microbial Synthesis of Nano materials -Biological Methods for Synthesis of nano - emulsions using bacteria, Fungi and Actinomycetes - Plants based nanoparticle synthesis - nanotechnology is a tool for sustainability, health, safety, and environmental issues.

Activity: Quiz

Nanomaterials for Remediation: Nano Membranes - Nano Meshes - Nano Fibres - Nano Clays and Adsorbents, - Zeolites - Nano Catalysts - Carbon Nano Tubes - Bio Polymers - Bio Metallic Iron Nano Particles - Nano Semi-Conductors - Photo catalysis - Nano-sensors.

Activity: Poster presentation on contemporary Nanometerials

Nano Remediation Technologies: Thermal, Physico - Chemical and Biological Methods - Nano materials as adsorbents and membrane process – Nano Filtration - Nanotechnology for water remediation and purification - Environmental benefits of nanomaterials.

Activity: Site visit/virtual tour for remediation sites

Nanoparticle transport – Physicochemical interactions - aggregation and deposition – behaviour in heterogeneous systems - Air born nanoparticles - Energy applications - Mechanical, Thermal and magnetic properties of nanomaterials.

Activity: Assignment

Ecotoxicological Impacts of Nanomaterials – Bio-distribution - Bioavailability – Antibacterial activity – Biotransformation - Toxicological effects of transport of nanomaterials in soil/sediments - Nano material toxicity – Life cycle risks of nanomaterials

Contemporary issues

Expert lectures from industry or R&D institutions / Industrial Visits

References:

1. Mark R Wiesner and Jean-Yves Bottero, Environmental nanotechnology: Applications and Impacts of Nanomaterials, 2nd edition, McGraw Hill, New York, 2017

2. Glen E Fryxell and Guozhong Cao, Environmental applications of nanomaterials-Synthesis, Sorbents, and Sensors, 2nd edition, Imperial College Press, UK, 2012
3. C. N. R. Rao, H.C. Mult. Achim Müller and A. K. Cheetham(Ed.), The Chemistry of Nanomaterials, Synthesis, Properties, and applications, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004
4. K. Mishra, Ed.,(2014). Application of nanotechnology in water Research, Wiley, Scrivener Publishing, Hoboken, New Jersey

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the synthesis routes, properties, and environmental applications of nanomaterials for remediation and pollution control.	-	-	-
CO2	**Apply** suitable nanomaterials and nano-remediation techniques for treating contaminated water, soil, and air, considering sustainability and safety aspects.	PO1 (3) PO3 (2)	3	-
CO3	**Analyze** the environmental fate, transport behavior, and ecotoxicological impacts of nanoparticles to evaluate their risks and life-cycle implications.	PO1 (3) PO2 (3)	2	3

EV25015	Water Quality Modelling	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the fundamentals of mathematical models and their importance in water quality modelling, and to impart the skills to use water quality modelling software for surface and groundwater quality modelling.

Modelling Insights

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- finite element, finite difference and finite volume methods.

Activity: Reproduction of research paper on water quality modelling

Pollutant Transport

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.

Activity: Assignment problems on advection velocity, dispersion coefficients, breakthrough curves.

Surface Water Quality Modelling

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

Activity: Quiz

Groundwater Quality Modelling

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

Water Quality Modelling Software

Exposure to surface water and groundwater quality modelling software's – MIKE 21, WASP, QUAL2E and MODFLOW – demonstration - case studies.

Activity: Case Study Report

References:

1. Steven C. Chapra, "Surface Water Quality Modelling", Tata McGraw-Hill Companies, Inc., New Delhi 2018.
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-Gang Ji, John Wiley & Sons, 2018.
4. “Modelling Groundwater Flow and Contaminant Transport By Jacob Bear, A. H.-D. Cheng, Springer Science & Business Media, 2010.
5. “Mathematical Modelling of Groundwater Pollution” Ne-Zheng Sun, Alexander Sun, Springer New York, 2012

E-Resources

1. https://www.unep.org/cobsea/news/story/e-learning-course-cities-and-marine-plastic-pollution-launched-world-ocean-day
2. https://archive.nptel.ac.in/courses/120/108/120108002/
3. https://www.unsdglearn.org/courses/cities-and-marine-plastic-pollution-building-a-circular-economy/

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the principles of water quality modelling, pollutant transport mechanisms, and model development processes.	-	-	-
CO2	**Apply** analytical and numerical methods (FEM, FDM, FVM) to develop and solve surface water and groundwater contaminant transport models.	PO1 (3) PO3 (2)	3	-
CO3	**Analyze** water quality modelling outputs using software tools (MIKE21, WASP, QUAL2E, MODFLOW) to evaluate system behaviour and environmental impacts.	PO1 (3) PO2 (2)	-	2

EV25016	Marine Pollution and Control	L	T	P	C
		3	0	0	3

Course Objective:

- To impart the knowledge about marine and coastal environment, ocean hydrodynamics, sources and effects of pollution on the marine environment, monitoring of marine pollutants and control measures.

Marine and Coastal Environment

Introduction to marine environment, coastal zones, properties of sea water, principles of marine geology, coastal features – beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes–the oceans and climate, Legal and regulatory frameworks – International Conventions - coastal zone regulation in India- national and international treaties.

Activity: Poster presentation on coastal features with its significance

Ocean Hydrodynamics

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

Activity: Technical Quiz/ Online Quiz on Ocean hydrodynamics

Marine Pollution Sources and Effects

Sources of marine pollution – role of GESAMP – point and non-point sources – transport path – dynamics - 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 ecosystems, human health and coastal economies.

Activity: Field visit to a nearby port/ harbour/ power plants and submission of report

Marine Pollution Monitoring

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

Activity: Seminar presentation on marine pollution monitoring techniques

Marine Pollution Control Measures

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.

Activity: Case study on examples of successful marine pollution control initiatives and best practices

References

1. R.B. Clark, C. Frid and M Atttrill, Marine Pollution, Oxford Science Publications, 5th Edition, 2017.
2. Tobias N. Hofer, Marine Pollution: New Research, Nova Publishers, 2018,
3. Laws, E.A., Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 2000.
4. Michael J. Kennish, Practical Handbook of Estuarine and Marine Pollution, Volume 10 of CRC Marine Science, CRC Press, 1996.
5. Aneena V Mathew, Understanding the effect of pollution on marine ecosystem of India, Lambert Academic publishing, 2023

E-resources

1. https://www.unep.org/cobsea/news/story/e-learning-course-cities-and-marine-plastic-pollution-launched-world-ocean-day
2. https://archive.nptel.ac.in/courses/120/108/120108002/
3. https://www.unsdglearn.org/courses/cities-and-marine-plastic-pollution-building-a-circular-economy/

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the characteristics of marine and coastal environments, ocean processes, and sources/effects of marine pollution.	-	-	-
CO2	**Apply** appropriate methods and tools for assessing ocean hydrodynamics, marine pollution monitoring, and pollutant transport in coastal waters.	PO1 (3) PO3 (2)	3	-
CO3	**Analyze** marine pollution control strategies, outfall design considerations, and integrated coastal zone management practices for sustainable coastal development.	PO1 (3) PO2 (3)	2	3

EV25017	Climate Change and Modelling	L	T	P	C
		3	0	0	3

Course Objective:

To understand the science of climate change, apply climate modeling tools for impact assessment, and evaluate strategies for research and sustainable environmental planning.

Climate Systems and Temporal Variability

Introduction – composition and structure of the atmosphere – weather versus climate – essential climate variables (temperature, precipitation, relative humidity, wind, radiation) – governing atmospheric equations (continuity, momentum, thermodynamic, state) – principles of numerical weather prediction (NWP) – overview of Global and Regional Climate Models (GCMs/RCMs) – use of coupled climate-model ensembles for future change projections and impact assessments.

Activity: Field Visit to IMD/SAC-ISRO/ Regional climate data centres.

IPCC Climate Projection Frameworks

Introduction to IPCC – mandate, structure, and assessment reports – foundational assumptions in climate scenario development – Representative Concentration Pathways (RCPs: 2.6, 4.5, 6.0, 8.5) – radiative forcing trajectories and associated emission trends – integration of Shared Socioeconomic Pathways (SSPs) with RCPs – relevance of scenarios in policy planning, mitigation strategies, and long-term climate impact assessments.

Activity: Expert talks on IPCC frameworks, climate policy, or regional downscaling techniques.

Global and Regional Climate Models

Overview of climate models – types and classifications – General Circulation Models (GCMs): structure, capabilities, and limitations – challenges in GCM-based projections – introduction to Regional Climate Models (RCMs) and Limited Area Models (LAMs) – key RCM frameworks and modelling systems – comparative analysis of GCMs and RCMs: strengths, limitations, and suitability for regional climate impact studies.

Activity: Thematic MCQs on climate models, RCPs, and GCM vs RCM.

Downscaling Techniques

Downscaling – GCM selection for regional applicability, ensemble generation principles, spatial–temporal domain configuration, resolution refinement, and variable specification – application of lateral boundary forcing – downscaling techniques: Statistical (e.g., BCSD, quantile mapping, ML-based) and Dynamical (e.g., WRF, RegCM via CORDEX) – methodological limitations and uncertainties.

Activity: Posters presentation showing atmospheric layers or downscaling flow.

Climate Model Evaluation and Processing

Model validation and calibration using bias correction and ensemble evaluation (e.g., CRPS, RMSE) – post-processing with tools like xarray, CDO, and ArcGIS – analysis using Python, R, Ferret, and GrADS – case studies: CMIP6-based heatwave trends

in Europe, CORDEX rainfall projections over South Asia, IPCC AR6 drought risk in Sub-Saharan Africa – impact assessment and adaptation planning for water resources, agriculture, and urban infrastructure.

Activity: Regional climate impact projects using CORDEX/CMIP data, Python/R-based model evaluations.

References:

1. IPCC Fifth Assessment Report, Cambridge University Press, Cambridge, UK, 2013
2. Neelin, J. David – *Climate Change and Climate Modelling*, Cambridge University Press, 2011.
3. McGuffie, Kendal & Henderson-Sellers, Ann – *A Climate Modelling Primer* (3rd ed., 2005)
4. Stocker, Thomas – *Introduction to Climate Modelling*, Springer, 2011
5. Archer, David – *Global Warming: Understanding the Forecast*, Blackwell Publishing, 2007

E-Resources (E-Books, MOOCs, Web URLs)

1. **NPTEL Online Course:**
   "Introduction to Climate Change"
   https://nptel.ac.in/courses/105103193
2. **NASA Earthdata (GCM/RCM Data Sources)**
   https://earthdata.nasa.gov
3. **CMIP6 Data and Case Studies**
   https://esgf-node.llnl.gov/projects/cmip6/
4. **IPCC Reports and Scenario Explorer**
   https://www.ipcc.ch
   https://tntcat.iiasa.ac.at/SspDb

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the fundamental components of the climate system, IPCC climate scenario frameworks, and the structure of global and regional climate models.	-	-	-
CO2	**Apply** downscaling techniques, climate scenario datasets (RCPs/SSPs), and modelling tools to generate regional climate projections.	PO1 (3) PO3 (2)	3	-
CO3	**Analyze** climate model outputs through validation, bias correction, and ensemble evaluation to assess climate impacts on sectors such as water, agriculture, and urban systems.	PO1 (3) PO2 (3)	2	3

EV25018	Operation and Maintenance of Water and Wastewater Treatment Systems	L	T	P	C
		3	0	0	3

Course Objective:

The course objectives include understanding the various operation and maintenance aspects of treatment processes, developing operational procedures, implementing maintenance strategies, troubleshooting issues, and ensuring safety and efficiency.

Basics of Operation and Maintenance

Introduction - Preventive and corrective maintenance scheduling - operation and maintenance Plan - proper and adequate tools, spare Modules - training requirements- laboratory control and analysis of pollutants - 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 – Laboratory equipment and glassware – case studies

Activity: Field visit to a WTP/ STP and report submission

Operation and Maintenance of Water Supply Systems

Operational problems, O&M practices and records of operation of reservoir and intakes – Dug wells - causes of failure of wells- rehabilitation of tube wells & bore wells- O&M of hand pump-prevention of corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance of water pumps - problems in the water distribution system and remedies- water quality monitoring

Activity: Technical Quiz/ Online Quiz on Water quality standards

Operation and Maintenance of Water Treatment Modules

Operation and maintenance in screen chamber, grit chamber and clarifiers- operation issues, troubleshooting guidelines and record keeping requirements for clarifier, equalization basins, neutralization Module - chemical storage and mixing equipment – chemical metering equipment - flash mixer –filters, thickeners and centrifuges- filter press - start-up and maintenance inspection - motors and pumps - hazards in chemical handling – jar test -chlorination equipment - membrane process systems- SDI and LSI determination- process chemistry and chemical dosage calculations- SOP-case studies

Activity: Seminar Presentation on O&M of any one of the water treatment Module of a WTP

Operation and Maintenance of Sewerage Systems and Pumping Machinery

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 – Pumping machinery - preventive and corrective maintenance of sewage pumps –

operation and maintenance of sewage pumping stations- maintenance hazards and operator protection –SOP-case studies

Activity: Poster presentation on precautions against gas hazards and infections in Sewerage systems

Operation and Maintenance of Secondary Treatment Modules and Storage Systems

Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- start up and shutdown procedures-DO, MLSS and SVI monitoring- trouble shooting guidelines –planning, organizing and controlling of plant operations – capacity building, O&M of sump and storage tanks –water meters - SOP-case studies

Activity: Model making and presentation of any one of the biological treatment Module

References

1. CPHEEO, Manual on operation and maintenance of water supply systems, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, Government of India, 2013
2. Ministry of Drinking Water and Sanitation, operation and maintenance manual for rural 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. J. Paul Guyer, An introduction to water supply systems operation and maintenance, Createspace Independent Pub, 2014.
6. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.1 and Vol.2, 2007.

E-resources

1. https://mohua.gov.in/upload/uploadfiles/files/Part-B-Chapter-1-Introduction.pdf
2. https://mohua.gov.in/upload/uploadfiles/files/Part-B-Chapter-5-Water-Treatment-Plant.pdf
3. https://tnussp.co.in/wp-content/uploads/2022/11/Detailed-Commissioning-and-OM-Manual-for-FSTPs-in-TN_21-nov-2022.pdf

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the principles, procedures, and safety practices involved in the operation and maintenance of water supply, sewerage, and treatment modules.	-	-	-
CO2	**Apply** appropriate O&M practices, troubleshooting steps, and monitoring techniques for pipelines, pumps, treatment units, and laboratory processes.	PO1 (2) PO3 (3)	3	2
CO3	**Analyze** operational data, performance issues, and failure scenarios to recommend suitable corrective measures and improve system efficiency and safety.	PO1 (3) PO3 (2)	3	2

EV25019	Artificial Intelligence in Environmental Reaction Engineering	L	T	P	C
		3	0	0	3

Course Objective:

To apply AI techniques to model, optimize, and evaluate environmental reaction systems for sustainable engineering solutions.

Fundamentals of Environmental Reactions and AI Applications

Introduction to environmental reactions – biodegradation, photochemical, redox and catalytic reactions – basic reactor types (batch, CSTR, PFR) – overview of AI and ML – supervised, unsupervised, and reinforcement learning – AI relevance to environmental systems – overview of AI tools in Python – case examples in environmental kinetics.

Activity: One-day visit to a municipal wastewater-treatment plant

Data Acquisition, Cleaning and Pre-Processing

Data sources: laboratory, sensors, SCADA – data characteristics (time series, noise, missing values) – data cleaning and transformation – feature engineering and selection for reaction systems – exploratory data analysis – data quality evaluation – open-source tools for data processing – case study: wastewater reactor dataset processing.

Activity: Poster presentation

Machine Learning for Kinetic Modelling and Parameter Estimation

Regression models – decision trees and ensemble methods – neural networks – model development, validation, and evaluation – model uncertainty and sensitivity – SHAP and LIME for interpretability – kinetics parameter prediction – case study: aerobic biodegradation reaction modeling.

Activity: In-class problem-solving session building a simple Python model

Optimization and Control Using AI

Optimisation of process parameters – genetic algorithms, PSO – reinforcement learning – model predictive control (MPC) – digital twins for environmental systems – AI for real-time monitoring and control – trade-off analysis: energy, cost, emissions – case study: AI optimization of ozonation reactor.

Activity: Short online quiz

Case Studies, Deployment and Ethics in AI for Environmental Engineering

Case studies: AI in biological treatment, catalytic converters, bioremediation – deployment strategies – explainable AI and model robustness – ethics and sustainability – future trends: quantum computing, autonomous labs – developing AI research proposals – guidelines for responsible AI in environmental domains.

Activity: Case study report

References:

1. Fogler, H. S. Elements of Chemical Reaction Engineering, 5th Edition, Pearson Education, 2020
2. Géron, A. Hands-On Machine Learning with Scikit-Learn, Keras& TensorFlow, 3rd Edition, O'Reilly Media, 2022
3. Sutton, R. S., & Barto, A. G. Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.
4. Nasr M., Negm A., Peng L. (eds.), Artificial Intelligence Applications for a Sustainable Environment, 1st ed., Springer, 2025

E-Resources :

#	Resource	Format / Provider	Usefulness
1	**Fogler 6e Screencasts** (LearnChemE)	Free video playlist	Step-by-step reactor-design worked examples. (learncheme.com)
2	**NPTEL: "Machine Learning for Earth System Sciences"** (IIT Kharagpur)	MOOC (12 weeks)	Focuses on ML applied to climate and environmental datasets—ideal for Module V case studies. (onlinecourses.nptel.ac.in)
3	**NPTEL: "Introduction to Machine Learning"** (IIT Madras)	MOOC	Solid mathematical foundation for supervised, unsupervised and RL algorithms (Modules II–III). (nptel.ac.in)
4	**Coursera: "AI for Everyone"** (Andrew Ng)	MOOC	Non-technical overview of ethical, deployment and organisational issues (Module V). (coursera.org)
5	**Coursera Collection: Andrew Ng's "Machine Learning" Specialization**	MOOC series	Hands-on Python notebooks useful for laboratory assignments and mini-projects. (coursera.org)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** environmental reaction fundamentals and the basic concepts of AI/ML relevant to environmental systems.	-	-	-
CO2	**Apply** data preprocessing, machine learning models, and AI tools to develop kinetic models and estimate reaction parameters.	PO1 (2) PO3 (3)	3	2
CO3	**Analyze** environmental processes using AI-driven optimization, control strategies, model interpretability, and ethical considerations for real-world applications.	PO1 (3) PO3 (2)	3	2

EV25020	Membrane Separation for Water and Wastewater Treatment	L	T	P	C
		3	0	0	3

Course Objective:

This course provides foundational and practical knowledge on membrane technologies for water and wastewater treatment, including design, operation, and sustainability. It emphasizes fouling control, system optimization, and real-world applications.

Membrane Filtration Processes

Principles of membrane filtration for solid-liquid separation – cross-flow filtration and membrane separation theory – mass transport mechanisms and concentration polarization – transmembrane pressure and membrane flux – types of membranes: porous, nonporous, symmetric, and asymmetric – membrane materials and structural configurations – modules: plate and frame, spiral wound, and hollow fiber – key factors affecting membrane performance – overview of membrane manufacturing techniques.

Activity: Poster presentation on membrane modules (spiral wound, hollow fiber, plate & frame)

Design and Application of Membrane Systems

Membrane module configurations and system components – design principles of membrane systems including module assembly and process control – low-pressure membrane technologies: microfiltration and ultrafiltration – diffusive membrane technologies: nanofiltration and reverse osmosis – electrodialysis systems: ion exchange membranes and process design – pump types and selection for membrane systems – operational considerations and economic analysis of membrane-based treatment plants.

Activity: Assignment on required pump specifications using TMP and flow requirements

Membrane Bioreactor (MBR) Technology

Evolution and historical development of MBRs – fundamentals of biological wastewater treatment – principles and configurations of membrane bioreactors – MBR design criteria and system integration – overview of commercial MBR technologies – membrane fouling mechanisms and control strategies –municipal and industrial MBR applications.

Activity: Case study - Compare three commercial MBR technologies (Kubota, ZeeWeed, Mitsubishi) in a short report.

Pretreatment and Post-Treatment for Membrane Systems

Membrane fouling mechanisms: particulate, mineral scaling, natural organic matter, and microbial biofoulants – characterization of source water quality – evaluation methods: Langlier Saturation Index (LSI), Silt Density Index (SDI), and other key parameters – impact of combined foulants on membrane performance – fouling control and cleaning strategies – pretreatment techniques: screening, coagulation, sand and membrane filtration, pH adjustment – real-time monitoring of pretreatment systems –

chemical cleaning systems and biofouling mitigation – post-treatment processes for water quality polishing and system protection.

Activity: Quiz

Case Studies in Membrane-Based Water and Wastewater Treatment

Real-world case studies on membrane system design for water and wastewater treatment – implementation of Zero Liquid Discharge (ZLD) systems – membrane-based desalination of brackish and seawater – project planning, execution, and economic feasibility – environmental challenges and reject/brine management strategies – integration of energy recovery systems in membrane treatment plant.

References

1. Arceivala, S. J. and Asolekar, S. R. Wastewater Treatment for Pollution Control. 3rd Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006.
2. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, McGraw-Hill, 2017.
3. Symon Jud, MBR Book – "Principles and application of MBR in water and wastewater treatment", Elservier, 2010
4. Nikolay Voutchkov, Desalination Engineering-Planning and Design, McGraw-Hill, Newyork, 2013.
5. Paul G. J. An Introduction to Advanced Wastewater Treatment (Wastewater treatment engineering), Independently Published, 2018.

E-Resources

1. **http://www.digimat.in/nptel/courses/video/103105121/L01.html**

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	**Explain** the principles, mechanisms, materials, and configurations of membrane filtration and bioreactor systems.	-	-	-
CO2	**Apply** membrane system design principles, pretreatment/post-treatment strategies, and operational considerations for water and wastewater treatment.	PO1 (3) PO3 (2)	3	-
CO3	**Analyze** membrane performance, fouling behavior, cleaning strategies, and treatment feasibility using real-world case studies and system data.	PO1 (3) PO2 (3)	2	3

EV25021	Air Quality Modeling	L	T	P	C
		3	0	0	3

Course Objective:

- To provide a basic understanding of air pollution, its sources, effects, monitoring techniques, regulatory standards, and the structure and behaviour of the atmosphere.
- To introduce the concepts of environmental modelling, including model development, transport phenomena, and chemical reaction kinetics.
- To provide knowledge on air pollution control devices, dispersion modelling, plume behaviour, and methods to control specific gaseous pollutants.
- To introduce air quality modelling techniques and their application in predicting pollutant dispersion and assessing air pollution impacts.
- To introduce students to commercial air quality modelling software and their practical applications in air pollution assessment.

Introduction

Introduction to air pollution, types of air pollutants, sources & classification of air pollutants and air pollution effects (the impacts of air pollution on human health, materials and ecosystem) – Ambient air quality monitoring techniques, Selection of monitoring locations, Air pollution indices, standards, norms, rules and regulations and air quality management plan – Composition and structure of the atmosphere, atmospheric energy balance, humidity, condensation, lapse rate and atmospheric stability, Wind rose diagram, Potential temperature.

Activity: Compute AQI from provided pollutant concentration data

Modeling Concepts

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

Activity: Poster presentation on advection, diffusion, dispersion, and chemical kinetics.

Modelling Protocols & Source Correction

Principle and design of particulate matter control devices – gravitational settling chambers, cyclone separators, and bag house filters, electrostatic precipitators, wet and dry scrubbers, design of gaseous pollutant control devices, Dispersion Modelling and Plume behaviour -Vehicular pollution control, indoor air quality monitoring and control, Control of specific gaseous pollutants – Control of sulphur dioxide, nitrogen oxides emission.

Activity: Design assignment on a cyclone separator or bag filter for a given flow rate and particle size distribution.

AIR Quality Models

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

Activity: Quiz

Software Package Applications

Commercial air quality models – ADMS, Airviro and USEPA models, AERMOD software (case study).

Activity: AERMOD case study

References

1. R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, “Fundamentals of Air Pollution”, Academic Press, New York, 1994.
2. J.L.Schnoor, "Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc., New York, 1996.
3. De N.N. (2000) Air Pollution Control Engineering, McGraw-Hill International Edition.
4. Godish T. (2004) Air Quality, Lewis Publishers, New York.
5. Lutgens F.K. and Tarbuck E.J. (1996) The Atmosphere an Introduction to Meteorology, Printice Hall Publisher, New Jersey.
6. Stern A.C. (editor) (1976) Air Pollution (Vol. I-VIII), Academic Press, New York.
7. Turner D.B. (1994) Workbook of Atmospheric Dispersion Estimates, 2nd ed., Ann Arbor, MI, Lewis Publishers.
8. Work K. and Warner S. (1980) Air Pollution: Sources and Control, M.: Myr.
9. Rao, C.S. “Environmental Pollution Control Engineering”, Wiley Eastern Ltd, Delhi.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain air pollution concepts, monitoring methods, atmospheric processes, and regulatory frameworks.	-	-	-
CO2	Apply modelling principles, control technologies, and dispersion concepts for analysing air quality.	PO1 (3) PO2 (2) PO3 (3)	3	3
CO3	Use air quality modelling tools/software to simulate pollutant behaviour and evaluate control strategies.	PO1 (3) PO2 (3) PO3 (2)	3	2

EV25022	Emerging contaminants and remediation technologies.	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the types, sources, occurrence, and regulatory frameworks of priority and emerging environmental contaminants affecting ecosystems and human health.
- To develop competency in characterizing contaminants, understanding their environmental fate, assessing associated risks, and appropriate remediation technologies.

Sources, Occurrence and Regulatory Requirements

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.

Activity: Poster presentation on Key groups of emerging contaminants

Characterization and Instrumentation

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.

Activity: Quiz

Environmental Fate and Transport

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.

Activity: Assignment on Simple mass-balance fate prediction

Remediation Technologies

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.

Activity: Case studies on successful application

Case Studies and Policy Implications

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.

Activity: Case studies of PFAS contamination in drinking water

References:

1. Alok Bhandari, Rao Y. Surampalli, Craig D. Adams, Pascale Champagne, Say Kee Ong, R. D. Tyagi and Tian Zhang, Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, US, 2009.
2. Caitlin H. Bell, Margaret Gentile, Erica Kalve, Ia Ross, John Horst and Suthan Suthersan, Emerging Contaminants Handbook, CRC Press, US, First edition, 2018.
3. Damia Barcelo and Mira Petrovic, Emerging Contaminants from Industrial and Municipal Waste Removal Technologies, Springer, Germany, 2012.
4. Francisco G, Calvo-Flores, Joaquin Isac-Garcia, Jose A. Dobado, Emerging Pollutants: Origin, Structure and Properties, Wiley & Sons, US, 2018.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Case study report (20%), Internal Examinations (40%)

	CO Description	PO Mapping	PSO1	PSO2
CO1	Explain the sources, occurrence, properties and regulatory aspects of emerging contaminants in various environmental media.	-	-	-
CO2	Analyze environmental fate, transport, risks and characterization of emerging contaminants using appropriate analytical and modelling tools.	PO1 (3) PO2 (2) PO3 (3)	3	3
CO3	Evaluate and select suitable remediation technologies and policy measures for controlling emerging contaminants through case studies.	PO1 (3) PO2 (3) PO3 (2)	3	2