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, Physics, Chemistry)
ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**))
SD – Skill Development
SL – Self Learning
OE – Open Elective

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.		Design of Biological Treatment systems	T	3	1	0	4	4	ES (PC)
2.		Air and Noise Pollution Control Engineering	T	3	0	0	3	3	ES (PC)
3.		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.		Environmental and Processes Monitoring Laboratory	L	0	0	4	4	2	ES (PC)
6.		Industry Oriented Course I	T	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.		Open Elective	T	3	0	0	3	3	OE
5.		Industry Oriented Course II	T	1	0	0	1	1	SD
6.		Summer Internship	---	---	---	---	---	1	SD
7.		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.		Project Work II	---	0	0	24	24	12	SD
TOTAL							**24**	**12**	

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 I 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 microbial-based solutions for environmental management.	PO1 (1) PO2 (3) PO3 (2)	2	1

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
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