KUMARAGURU COLLEGE OF TECHNOLOGY,
An autonomous Institution affiliated to Anna University, Chennai
COIMBATORE – 641 049.

M.E. ENVIRONMENTAL ENGINEERING

REGULATIONS 2024

CURRICULUM AND SYLLABI

I to IV Semesters

Department of Civil Engineering

VISION

Department of Civil Engineering is striving to become as a world class Academic Centre for quality education and research in diverse areas of Civil Engineering, with a strong social commitment

MISSION

- Producing highly competent and technologically capable professionals and motivated young academicians
- Providing quality education in undergraduate and post graduate levels, with strong emphasis on professional ethics and social commitment.
- Developing a scholastic environment for the state of art research, resulting in practical applications.
- Undertaking professional consultancy services in diverse areas of Civil Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Environmental Engineering Postgraduate Program are toprepare the students:

PEO1: To provide graduates the fundamental and the advanced knowledge on Environmental Engineering towards pursuing higher education, and to take part in providing feasible solutions considering the societal and technical constraints for sustainable management and development

PEO2: To be a platform that facilitates the graduates towards addressing environmental issues throughresearch and development applying appropriate techniques

PEO3: To inculcate the ethics and the professionalism among the graduates that is to be practiced in their profession considering public health & safety, societal and environmental factors.

PROGRAM OUTCOMES (POs)

Graduates of the Environmental Engineering Postgraduate Program should have the ability to:

PO1: Independently carry out research /investigation and development work to solve practical problems

PO2: Write and present a substantial technical report/document

PO3: Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: Extract pertinent information through literature review and experiments, apply appropriate research methods and tools, analyze data and contribute to the advancement of scientific or technological knowledge in engineering, individually or as a team

PO5: Design and apply relevant techniques, resources and technological advancements to tackle

complex engineering tasks

PO6 : An ability to evaluate wide range of problem statement and arrive feasible and sustainable solutions considering public health, safety and other environmental factors in the core areas of expertise

KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049

REGULATIONS 2024

M.E. (ENVIRONMENTAL ENGINEERING)

KUMARAGURU COLLEGE OF TECHNOLOGY									
DEPARTMENT OF CIVIL ENGINEERING REGULATION 2024 M.E. Environmental Engineering - Curriculum									
Semester I									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24MAI501	Statistical methods for Engineers	Embedded	ES	3	0	2	0	4
2	24INT001	Research Methodology & IPR	Theory	ES	3	0	0	0	3
3	24ENI501	Environmental Chemistry & Microbiology	Embedded	ES	3	0	2	0	4
4	24ENI502	Environmental Quality Modelling	Embedded	ES	2	0	2	0	3
5	24ENT503	Design of water and wastewater treatment systems	Theory	PC	3	0	0	0	3
6	24ENT504	Solid and Hazardous Waste Management	Theory	PC	3	0	0	0	3
7	24ENP505	Water and Wastewater Processing Laboratory	Laboratory	PC	0	0	2	0	1
								Total Credits	**21**
								Total Contact Hours/week	**25**
Semester II									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENT506	Environmental Impact Assessment & LCA	Theory	PC	3	0	0	0	3
2	24ENT507	Nanotechnology in Environmental Engineering	Theory	PC	3	0	0	0	3
3	24ENI508	Air & Noise pollution Control	Embedded	PC	3	0	2	0	4
4	24ENI509	GIS in Environmental Planning & Management	Embedded	PC	1	0	4	0	3
5	24ENE0YY	Professional Elective – I	Theory	PE	3	0	0	0	3
6	24ENE0YY	Professional Elective – II	Theory	PE	3	0	0	0	3
7	24ENJ501	Technical Seminar	Project	PRJ	0	0	0	2	1
								Total Credits	**20**
								Total Contact Hours/week	**24**

Semester III									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENC0YY	Professional Elective – III	Theory	PE	2	0	0	2	3
2	24ENE0YY	Professional Elective – IV	Theory	PE	3	0	0	0	3
3	24ENE0YY	Professional Elective – V	Theory	PE	3	0	0	0	3
4	24ENJ601	Industrial Training	Project	PRJ	0	0	0	2	2
5	24ENJ602	Project Phase-I	Project	PRJ	0	0	0	20	10
								Total Credits	**21**
								Total Contact Hours/week	**29**
*Mandatory for a minimum period of ONE month during II semester vacation #Student can opt Project Phase -I as Internship in Industry or Research labs									

Semester IV									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENJ603	Project Phase – II	Project	PRJ	0	0	0	40	20
								Total Credits	**20**
								Total Contact Hours/week	**40**
#Student can opt Project Phase – II as Internship in Industrial or Research labs									

PROFESSIONAL ELECTIVES									
TRACK I – INDUSTRIAL DRIVEN ELECTIVES									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENC001	Cleaner production and circular economy	Embedded	PE	2	0	0	2	3
2	24ENC002	Environmental Economics and Legislation	Embedded	PE	2	0	0	2	3
3	24ENC003	Environmental Analysis: Techniques & Instrumentation	Embedded	PE	2	0	0	2	3
4	24ENC004	Environmental Audit & Life cycle assessment	Embedded	PE	2	0	0	2	3
5	24ENC005	Environmental Social Governance	Embedded	PE	2	0	0	2	3
6	24ENC006	Occupational Health & Safety	Embedded	PE	2	0	0	2	3
7	24ENC007	Rural water supply and onsite sanitation	Embedded	PE	2	0	0	2	3

TRACK II – ADVANCED ELECTIVES									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENE008	Advanced oxidation processes	Theory	PE	3	0	0	0	3
2	24ENE009	Design of Environmental Engineering structures	Theory	PE	3	0	0	0	3
3	24ENE010	Environmental System Analysis	Theory	PE	3	0	0	0	3
4	24ENE011	Industrial Wastewater treatment	Theory	PE	3	0	0	0	3
5	24ENE012	Landfill techniques and Site Remediation	Theory	PE	3	0	0	0	3
6	24ENE013	Marine pollution & control	Theory	PE	3	0	0	0	3
7	24ENE014	Membrane separation process for water and wastewater treatment	Theory	PE	3	0	0	0	3
8	24ENE015	Transport of water and wastewater	Theory	PE	3	0	0	0	3
TRACK III – ELECTIVES ON EMERGING DOMAINS									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24ENE016	Climate Change, adaptation and Modelling	Theory	PE	3	0	0	0	3
2	24ENE017	Ecology and Ecosystem management	Theory	PE	3	0	0	0	3
3	24ENE018	Energy and Environmental Engineering	Theory	PE	3	0	0	0	3
4	24ENE019	Environmental Risks: Hazard, Assessment and Management	Theory	PE	3	0	0	0	3
5	24ENE020	Sustainable Built Environment	Theory	PE	3	0	0	0	3

Semesterwise Credits	
Semester - I	21
Semester - II	20
Semester - III	21
Semester - IV	20
Total Credits	**82**

Course types	Credits
Basic Science	4
Engineering Science	7
Professional Core	23
Professional Electives	15
Project/Internship	32
Seminar	1
Total Credits	**82**

SEMESTER I

24MAI501	Statistical Methods for Engineers (Common to CN, EN, MB)	L	T	P	J	C
		3	0	2	0	4
BS		SDG	9, 10, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	Statistical Tables

Course Objectives:	
The purpose of taking this course is to:	
1	learn key statistical concepts and apply estimation techniques
2	perform hypothesis testing for large and small samples
3	build knowledge in using correlations techniques and regression models
4	develop student's skills in experimental design and multivariate data analysis

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply different method and techniques to estimate statistical parameters	Ap
CO 2	apply various statistical methods for hypothesis testing of sample data	Ap
CO 3	apply hypothetical testing to compare and assess the independence of attributes	Ap
CO 4	apply multiple and partial correlation analysis, least squares regression in determining the factors relating engineering data	Ap
CO 5	analyse the effectiveness of experimental designs through Analysis of Variance	An
CO 6	apply the multivariate concepts and compute covariance and correlation matrices	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3	3		3	
2	3	3	3			
3	3		2	3		3
4	3	3		3		3
5	3	3				
6	2	2			3	

Course Content

ESTIMATION THEORY Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments. **Practical Component** Introduction to R programming Mean, Median and standard deviation	**9 Hours** **6 Hours**
TESTING OF HYPOTHESIS Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportion) – Small samples – t – test (single mean,	**9 Hours**

difference of means, paired t- test) – F – test (variance ratio test) – Chi-square test – Tests for independence of attributes. **Practical Component** Application of Student – t test Application of F test Application of Chi-square test	**8 Hours**
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 coefficients. **Practical Component** Applications of Correlation coefficient Applications of partial correlation and Multiple Correlation	**9 Hours** **6 Hours**
DESIGN OF EXPERIMENTS Principles of experimental design – Completely randomized design– Randomized block design –Latin square design. **Practical Component** ANOVA – one-way classification ANOVA – two-way classification	**9 Hours** **6 Hours**
MULTIVARIATE ANALYSIS Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components–Principal components from standardized variables. **Practical Component** Perform PCA on multivariate data and interpret principal components.	**9 Hours** **4 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 75

Learning Resources

Textbooks:

1. Devore, J.L., Probability and statistics for Engineering and the Sciences, Thomson and Duxbury, Singapore, 9th Edition,2015.
2. Freund J.E., Mathematical Statistics, Prentice Hall of India, 5th Edition,2001.
3. Gupta S.C, and Kapur J.N., Fundamentals of Mathematical Statistics, 10th Revised Edition, 2000, Sultan & Chand, Publishers, New Delhi, Reprint 2002.

Reference books & Weblinks:

1. Johnson, R.A., and Wichern, D.W., Applied Multivariate Statistical Analysis, Pearson Education, Asia, 6th Edition, 2007.
2. Johnson. R. A., Miller & Freund's Probability and Statistics for Engineers, 7th Edition, Pearson Education, Delhi, 2005.
3. Spiegel, M.R. and Stephens, L.J. Schaum's outlines, Statistics, Tata McGraw-Hill, 3rd Edition, 2000.

Online Resources (Weblinks)

1. https://www.khanacademy.org/math/statistics-probability
2. https://archive.nptel.ac.in/courses/103/106/103106120/
3. https://onlinecourses.nptel.ac.in/noc21_ma74/preview

Assessment (Embedded course)

SA I & SAII, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE), Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Mr. Ramesh V.S., STEPS Knowledge Services Private Limited, Coimbatore. Mr.Jayakumar Venkatesan, Valles Marineris International Private Limited- Chennai. Mr. Imran Khan, GE Transportation Company, Bangalore	Dr.T.Govindan, Government College of Engineering, Srirangam, Trichy. Dr.C.Porkodi, PSG College of Technology, Coimbatore. Dr.P.Paramanathan, Amrita Vishwa Vidyapeetham, Coimbatore.		Dr. R.Marudhachalam, Dr. R. Rajkumar, Department of Mathematics
Recommended by BoS on	16.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24INT501	Research Methodology and IPR (Common to CN, EN, MB, ST)	L	T	P	J	C
		3	0	0	0	3
BS		SDG	9,12,13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	equip students with the knowledge and skills necessary to design, conduct and critically evaluate research
2	draft research reports and present effective research findings
3	foster an understanding of intellectual property rights and ethical considerations essential for successful research and innovation

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply the scientific method and research planning steps to formulate research problems and objectives	Ap
CO 2	analyze different research designs and ethical considerations to classify research types and ensure ethical integrity	An
CO 3	evaluate the structure and components of research reports to organize and present research findings effectively	E
CO 4	interpret data collection tools and statistical methods to visualize and analyze biological research data	An
CO 5	create a research proposal incorporating IPR principles to develop innovative and ethically sound research plans	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3		3	3	
2	3	3		3		
3	3			3		3
4	3	3		3		3
5	3	3		3		
6	2	2		3	3	

Course Content

INTRODUCTION TO RESEARCH METHODS Definition and Objectives of Research, Scientific Method, Various Steps in Scientific Research, Research Planning, Selection of a Problem for Research, Formulation of Selected Problems, Purpose of the Research, Formulation of Research Objectives, Formulation of Research Questions, Hypotheses Generation and Evaluation, Literature Search and Review Process.	**9 Hours**

RESEARCH DESIGN AND ETHICS Types and Methods of Research, Classification of Research, Research Ethics: Informed Consent, Confidentiality, Data Protection, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research, Construction of Questionnaires, Pilot Studies, and Pre-tests, Data Collection Methods, Processing, Editing, Classification, and Coding Validity, Reliability, Ethical Dilemmas and Solutions	**9 Hours**
RESEARCH REPORTS Components of Research Articles, Manuscripts, Thesis, and Review Papers, Preparation of Thesis Documents: Referencing, In-text Citations, Tools like Endnote, Mendeley, Writing Techniques: CARS Model, Organizing Literature Review, Materials, and Methods Critical Thinking for Writing the Discussion Section. **Case Study:** Comparison of Research Articles with and without Referencing Tools	**9 Hours**
DATA COLLECTION AND ANALYSIS FOR RESEARCH Tools for Data Collection: Clinical Trials, Surveys, Questionnaires, Observational Methods, Data Management and Preparation, Overview of Statistical Concepts, Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation, Data Visualization Techniques **Case Study:** Journal Club on Research Papers Published in Tier 1 Journals	**9 Hours**
INTELLECTUAL PROPERTY RIGHTS (IPR) AND RESEARCH GRANTS Introduction to Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade Secrets, Importance of IPR in Research and Innovation, developing a Research Proposal: Components, Do's and Don'ts, Writing Winning Research Proposals, Peer Review, and Feedback, Finalizing Research Plans. **Case Study:** Evaluating Successful Research Proposals and Understanding the Role of IPR	**9 Hours**

Theory Hours: 45	**Tutorial Hours: 0**	**Practical Hours: 0**	**Project Hours: 0**	**Total Hours: 45**

Learning Resources:

Textbooks:

1. Cooper, D. R., Schindler, P. S., & Sharma, J. K. (2012). Business research methods (11th ed.). Tata McGraw Hill Education.
2. Hazari, A. (2023). Research Methodology for Allied Health Professionals. Springer Nature Singapore.
3. Goh, K. M. (2023). Research Methodology in Bioscience and Biotechnology. Springer.
4. Ganguli, P. (2017). Intellectual property rights: Unleashing the knowledge economy. McGraw Hill Education.

Reference books

1. AJIET. (n.d.). *Lecture Notes on Research Methodology & Intellectual Property Rights*. Retrieved from https://www.ajiet.edu.in/img/basic-science/21RMI56%20notes.pdf
2. Oxford University Press. (n.d.). *Handbook of Intellectual Property Research: Lenses, Methods, and Perspectives*. Retrieved from https://academic.oup.com/book/41122
3. Goddard, W., & Melville, S. (2004). *Research Methodology: An Introduction for Science & Engineering Students*. Juta and Company Ltd.
4. Kumar, R. (2014). *Research Methodology: A Step by Step Guide for Beginners* (4th ed.). SAGE Publications

Online Resources (Weblinks)

1. https://hrdc.ugc.ac.in/Web/Home/ViewCourseDetails/842/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by		
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**
		Dr.K.Ram, Department of Biotechnology
Recommended by BoS on	13.08.2024	
Academic Council Approval	No: 27	**Date** 24.08.2024

24ENI501	Environmental Chemistry & Microbiology	L	T	P	J	C
		3	0	2	0	4
ES		SDG	6, 14, 15			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	understand the concepts and principles of ions, their equilibrium and reactions in aquatic chemistry
2	gain knowledge on complex chemical systems and appropriate techniques
3	inculcate the knowledge on surface chemistry of fluids and its properties to degrade synthetic pollutants
4	identify the microbial metabolism involved in wastewater treatment systems
5	understand the biodegradation and toxicology of the existing environment
6	isolate the microbes involved in specific biological activity and understand their environmental significance

Course Outcomes		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO1	analyze and solve reaction chemistry involved in equilibrium and redox reactions	An
CO2	derive and develop kinetic equations (chemical and enzyematic) and interpret the influential parameters in water and wastewater treatment processes	An
CO3	adopt appropriate technology based on fluid surface chemistry in degrading contaminants	Ap
CO4	classify microorganisms and explain their metabolic pathways in aerobic and anaerobic conditions.	U
CO5	analyze real time case studies on biotransformation, bioaccumulation, and ecotoxicology	Ap
CO6	characterize and identify the microbial components in an effluent	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	2			3
2	3	2	2	2	2	3
3	3	2	2			3
4	3	2	2			3
5	2	2	2			2
6	3	3	3			3

Course Content

AQUATIC CHEMISTRY Concentration of solutions – Calculations, Ionic equilibrium of weak electrolytes – Le chatelier's principles - common ion effect, Buffer solutions - Buffer index - Change of pH with salt concentrations, Solubility product Salt hydrolysis – Problems, Significance of Redox reactions - EMF and Electrode potential - Applications of potentiometry in pH measurements	**9 Hours**
CHEMICAL KINETICS Rate constants and order of reactions: first and second order reactions – problems – effect of temperature on reaction rates – Derivation of Arrhenius equation – problems – consecutive reactions basic concepts of enzymes, cofactors – enzyme catalyzed reactions – Temperaturedependence of enzyme activity– Enzyme kinetics-Michalei's Menton equation – significance.	**9 Hours**
COLLOIDS CHEMISTRY Environmental application of Colloids – types, Properties – electrical, optical and electro kinetic properties – double layer theory and Schulz Hardy rule - Destabilization and destruction of colloids – hydrophilic and hydrophobic colloids - colloidal electrolytes, Surfactants, soaps and detergents – types and ingredients, Biodegradation of detergents and environmental significance	**9 Hours**
CHARACTERISTICS AND METABOLISM OF MICROORGANISMS Classification of microorganisms – prokaryotic and eukaryotic, cell structure and characteristics, Structure of DNA and RNA - DNA replication, Recombinant DNA technology. Carbohydrate, protein and lipid metabolism –aerobic and anaerobic respiration - fermentation, glycolysis, Kerb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.	**9 Hours**
TOXICOLOGY Xenobiotics – Classification of pollutants, biotransformation and biodegradation – Enzymatic processes in Bio-degradation, Bio-concentration, Bio-magnification, Bio-monitoring, Ecotoxicology - Case studies	**9 Hours**
CHARACTERIZATION OF MICROORGANISMS (Practical Component) 1. Preparation of culture media, serial dilution and plating 2. Measurement of growth of microorganisms 3. Sampling of microorganisms from air, water and soil, staining simple and gram staining 4. Effect of pH, temperature on microbial growth 5. Pollutant removal using microbes from industrial effluent	**30 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 75

Learning Resources:

Textbooks:

1. Colin Baird., Environmental Chemistry, Freeman and company, New York, 5thEdition, 2012.
2. Frank C. Lu and Sam Kacew, LU"s Basic Toxicology, Taylor & Francis, London 4thEdition, 2002.
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press. 2nd edition, 2009
4. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.

Reference books

1. Bhatia S.C., Handbook of Environmental Microbiology", Part 1 and 2, AtlanticPublisher Gabriel Bitton, Wastewater Microbiology, 2nd Edition, 2007.
2. Barceló, D., & Kostianoy, A. G. (Eds.). (2020). *The Handbook of Environmental Chemistry*. Springer. Retrieved from Springer
3. Koren, H., & Bisesi, M. (Eds.). (2003). *Handbook of Environmental Health* (4th ed.). CRC Press.
4. Maier, R. M., Pepper, I. L., & Gerba, C. P. (Eds.). (2009). *Environmental Microbiology* (2nd ed.). Academic Press.
5. Patnaik, P. (2003). *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*. CRC Press.
6. Wang, L. K., Pereira, N. C., & Hung, Y. T. (Eds.). (2004). *Handbook of Environmental Engineering*. Humana Press.

Online Resources (Weblinks)

1. https://onlinecourses.nptel.ac.in/noc21_bt22/preview
2. https://ocw.mit.edu/courses/1-89-environmental-microbiology-fall-2004/
3. https://www.udemy.com/course/rahsoft-introduction-to-environmental-chemistry-online-course-rahch320/?couponCode=IND21PM

Assessment (Embedded course)

SA I & SAII, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE), Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. A. Geethakarthi, Department of Civil Engineering

Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENI502	Environmental Quality Modelling	L	T	P	J	C
		2	0	2	0	3
PC		SDG	6, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	provides an introduction to the principles and practices of modelling environmental systems, with a focus on water quality, air quality, and pollution dispersion.
2	learn various models and to predict environmental quality under various scenarios
3	gain proficiency in using software tools for environmental modelling

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand the theoretical basis for environmental modelling	U
CO2	analyze environmental data to solve environmental models using mathematical methods and techniques	An
CO3	develop and interpret models for predicting environmental quality	Ap
CO4	apply models to real-world environmental problems	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	2	3	3	2	1	3
2	2	3	3	2	1	3
3	2	3	3	2	2	3
4	2	3	3	2	1	3

Course Content

INTRODUCTION TO ENVIRONMENTAL MODELLING Overview of environmental systems - Role and importance of models in environmental studies - Types of environmental models (deterministic vs. stochastic, static vs. dynamic, etc.)	**4 Hours**
MATHEMATICAL FOUNDATIONS Basic differential equations and their role in modelling - Numerical methods for solving environmental models - Statistical tools for environmental data analysis **Practical Component** Data preprocessing, statistical analysis, correlation analysis, linear regression	**4 Hours** **6 Hours**
WATER QUALITY MODELLING	**8 Hours**

River and stream water quality models - Lake and reservoir water quality models- Groundwater contamination modelling - Modelling of water treatment processes **Practical Component** 1. One dimensional river water quality model development – point source Dissolved oxygen simulation 2. Groundwater balance model development	**10 Hours**
AIR QUALITY MODELING Meteorological modelling: weather patterns and their impact on pollutant dispersion - Climate modelling: long-term atmospheric processes **Practical Component** 1. Gaussian dispersion model development, 2. Climate data analysis	**8 Hours** **8 Hours**
MODELING ECOSYSTEMS Population dynamics models - Ecosystem modelling: nutrient flows, food webs, and ecological interactions - Biodiversity and species distribution modelling **Practical Component** 1. Food web model development 2. Population data analysis **Software Tools for Environmental Modeling** a. Introduction to modelling packages (MATLAB, HEC-RAS, WEKA, AQUATOX) b. Case studies and hands-on modeling exercises **Model Calibration and Validation** a. Techniques for calibrating environmental models b. Methods for model validation and verification c. Sensitivity and uncertainty analysis	**6 Hours** **6 Hours**

Theory Hours:	30	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	60

Learning Resources:

Textbooks:

1. Schnoor, J. L. (1996). *Environmental modeling: Fate and transport of pollutants in water, air, and soil*. Wiley.
2. Chapra, S. C. (2008). *Surface water quality modeling*. Waveland Press, Inc.

Reference books:

1. Soetart, K., & Herman, P. M. J. (2009). *A practical guide to ecological modeling*. Springer.
2. Introduction to modeling and simulation. (n.d.). Johns Hopkins University Applied Physics Laboratory. Retrieved from https://jhuapl.edu
3. https://educationalsolutions.github.io/explanation.pdf
4. Streeter-Phelps equation / Do sag curve. https://educationalsolutions.github.io/streeter-phelps-equation-do-sag-curve
5. Groundwater balance Ministry of Water Resources. http://mowr.gov.in
6. Self-study notes - Gaussian plumes. University of Western Ontario. https://uwo.ca/self-study-notes-gaussian-plumes
7. Modelling population dynamics. (n.d.). Colorado State University. https://colostate.edu/modeling-population-dynamics

Online Resources (Weblinks)

https://onlinecourses.nptel.ac.in/noc20_ch05/preview

Assessment (Embedded course)

SA I & SAII, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE), Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Ravi Galkate Scientist-F & Head National Institute of Hydrology Central India Hydrology Bhopal– 462016	Dr.S.T.Ramesh, Professor, National Institute of Technology, Trichy		Dr. N. Ramsundram Ms.S.Rajalakshmi, Department of Civil Engineering
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENT503	Design of Water and Wastewater Treatment Systems	L	T	P	J	C
		3	0	0	0	3
PC		SDG	6, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	educate the students on the principles and process designs of various physio-chemical treatment systems for water and wastewater
2	gain competency in the process employed in design of treatment systems and the components comprising such systems,
3	develop skill among the students to design appropriate treatment systems based on the water/wastewater characterization

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	categorize the flow characteristics of water and wastewater and their hydraulic profiles	U
CO 2	apply the appropriate water and wastewater treatment process units based on their working principles and mechanisms	Ap
CO 3	design of aerobic, anaerobic and other advanced wastewater treatment processes under suitable kinetic conditions	An
CO 4	design of low-cost natural water treatment and sludge disposal methods	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3		2	
2	3		3		2	
3	3		3		2	
4	3		3		2	

Course Content

INTRODUCTION Characteristics of water and wastewater - flow variations, types of reactors and reactors analysis. wastewater treatment flow diagrams and hydraulic Profile. Capabilities and limitations of conventional water and wastewater treatment methods - Need for advanced treatment of water and wastewater	**7 Hours**

ADVANCED WATER TREATMENT Advanced water treatment- Iron and manganese removal, gas transfer – mass transfer coefficient Adsorption – Kinetics and Isotherms, corrosion control, ion exchange, electro-dialysis, reverse osmosis – stripping and crystallization – membrane separation - disinfection – solvent extraction - fluoride management - PID - construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends	**10 Hours**
ADVANCED WASTEWATER TREATMENT Aerobic, anaerobic, suspended and attached growth systems. Kinetics of biological treatment systems – Biokinetic constants and their determination, batch and continuous systems Nitrogen and phosphorus removal methods, Methods for the removal of heavy metals, oil and refractory organics, Micro-screening, ultra-filtration, centrifugation and other advanced physical methods	**9 Hours**
DESIGN OF WASTEWATER TREATMENT PLANTS Theoretical principles and design considerations – suspended growth system - conventional activated sludge process and its modifications. Theoretical principles and design considerations – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds	**10 Hours**
NATURAL AND SLUDGE TREATMENT SYSTEMS Ponds and lagoons - Wetlands and root zone systems - Surface and ground water treatment for potable water supply- Rural water supply - Separation – Sludge dewatering and thickening, volume reduction, conditioning and digestion – aerobic and anaerobic	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources:

Textbooks:

1. Metcalf and Eddy. Inc., Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Company Limited, New Delhi, 4th edition, 2003.
2. Peavy, H. S., Rowe, D. R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York, 1st Edition 2013.
3. Qasim, S.R., Motley, E.M. and Zhu.G. "Water works Engineering – Planning, Design and Operation", Prentice Hall, New Delhi, 2002.
4. Arceivala S.J., and Asolekar S.R "Wastewater Treatment for Pollution Control and reuse "McGraw Hill, 3rd Edition, New Delhi, 2007.

Reference books & Weblinks:

1. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. Droste, R. L., & Gehr, R. L. (2018). *Theory and Practice of Water and Wastewater Treatment* (2nd ed.). Wiley
3. Hammer, M. J., & Hammer, M. J. Jr. (2012). *Water and Wastewater Technology* (7th ed.). Pearson Education
4. Spellman, F.R. "Handbook of Water and Wastewater Treatment Plant operations", CRC Press, New York, 2009.
5. Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2003). *Wastewater Engineering: Treatment and Reuse* (4th ed.). McGraw-Hill.

Online Resources (Weblinks)

1. https://www.udemy.com/course/the-complete-course-in-water-and-wastewater-treatment/
2. https://ep.jhu.edu/courses/575746-water-and-wastewater-treatment-plant-design/

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution		Internal Expert(s)
			Dr.G.L.Sathamoorthy, Department of Civil Engineering
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENT504	Solid And Hazardous Waste Management	L	T	P	J	C
		3	0	0	0	3
PC		SDG	6, 11, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	inculcate students on significance of integrated waste management and legislative frameworks to mitigate risks to human health and the environment.
2	impart knowledge and skills relevant to minimization, storage, collection, transport, recycling, processing and disposal of solid and hazardous wastes
3	develop skill among the students the principles and practices of the various waste disposal methods abiding the design criteria, operation control and monitoring

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	analyze the types of wastes and quantify the impacts of disposing wastes to human health and ecosystem.	An
CO 2	develop a waste characterization plan and implement waste reduction and recycling strategies, including Extended Producer Responsibility (EPR) and circular economy practices	Ap
CO 3	design systems and processes to effectively minimize, store, collect, transport, and recycle waste to meet specific requirements under given conditions	An
CO 4	understand the principles of waste processing technologies to select appropriate methods for processing solid and hazardous wastes, focusing on environmental control.	U
CO 5	design an ultimate waste disposal system and apply integrated waste management concepts to real-world scenarios, supported by case studies	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3	3			3
2	3	3	3			3
3	3	3	3			3
4	3	3	3			3
5	3	3	3			3

Course Content

WASTE CLASSIFICATION AND QUANTIFYING IMPACT OF WASTE DISPOSAL Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and facilities - roles of stakeholders in waste management - impacts of disposing wastes - quantification of the impacts- quantitative risk analysis- human health risk analysis - carcinogenic, non-carcinogenic, microbial (QMRA) - ecological risk analysis	**7 Hours**
WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING Waste sampling and characterization plan - Overview of Global and National Waste Generation Trends – physical composition, chemical and biological properties – hazardous characteristics – ignitability, corrosivity and TCLP tests – source reduction, and onsite storage of wastes – Waste Exchange – recycling of plastics, C&D wastes and E- Waste - Waste Avoidance options - Waste Audit - Extended Producer Responsibility (EPR) - Circular Economy and Sustainable Waste Management Practices - Case Studies on Successful Waste Minimization and Recovery Programs	**9 Hours**
WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY Door to Door Waste Collection System & Segregation of Waste – Waste Logistics - analysis of hauled and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes - Occupational Health and Safety in Waste Handling - principles and design of transfer and transport facilities - hazardous waste logistics and manifests - mechanical processing and material separation technologies – Size reduction – size separation - density separation - magnetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – case studies on waste collection and material recovery	**10 Hours**
BIOLOGICAL AND THERMAL PROCESSING OF WASTES Biological and thermochemical conversion technologies – composting – bio methanation – Incineration and co-generation of energy using waste – Pyrolysis- Plasma arc gasification – Hydrogenation – Hydrolysis - principles and design of biological and thermal treatment facilities – Processing waste to energy rich value products and By-Products - operation of facilities and environmental controls - treatment of biomedical wastes – case studies on emerging waste processing technologies	**10 Hours**
WASTE DISPOSAL Waste Disposal in Landfills – Types of Landfills - Site Selection - Components & configuration - liner and cover systems – geo-synthetic clay liners and geo membranes – Design, Construction, Operational controls, Closure and Environmental monitoring of Landfills - Leachate collection, treatment and gas management - landfill bioreactors – rehabilitation of open dumps and biomining of dumpsites - remediation of contaminated sites - Integrated Waste Management concepts - Case studies	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources:

Textbooks:

1. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018
2. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, Wiley, 2010
3. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
4. Rao M.N, Razia Sultana, Sri Harsha Kota, solid and hazardous waste management – Science and Engineering, Butterworth-Heinemann, 2016

Reference books & Weblinks:

1. CPHEEO, “Manual on Municipal Solid waste management, Vol I, II and III, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2016.
2. John Pitchtel, Waste Management Practices, CRC Press, Taylor and Francis Group,2014.
3. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York,2010.
4. William A. Worrell, P. Aarne Vesilind, Christian Ludwig, Solid Waste Engineering - A Global Perspective, 3rd Edition, Cengage Learning, 2017.

Online Resources (Weblinks)

1. https://www.coursera.org/learn/solid-waste-management
2. https://onlinecourses.swayam2.ac.in/ugc19_bt18/preview
3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/281

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr.A.Gandhimathi, Ms.S,Rajalakshmi, Department of Civil Engineering

Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENP505	Water and Wastewater Processing Laboratory	L	T	P	J	C
		0	0	2	0	1
PC		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	enable the students in adopting field sampling procedures and characterization of water/effluents as per international standards
2	gain in-depth and practical knowledge on Unit operation and process treatments
3	provide hands on training with sophisticated analytical instruments to meet the industrial requirements

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	adopt appropriate sampling methods and techniques for water/wastewater analysis	Ap
CO2	characterize various physio-chemical parameters of water/effluent samples using volumetric analysis	Ap
CO3	characterize the toxic heavy metals in water/effluent samples using analytical instruments	Ap
CO4	conduct the performance studies of the various Unit operations and processes	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1		3	3			3
2		3	3			3
3		3	3			3
4		3	3			3

Course Content

1. Sampling and preservation methods and signification of characterization of water and wastewater – A Case study 2. Performance efficiency and optimum dosage of a coagulant for a domestic/Industrial effluent (determine the suitable physio-chemical parameters using volumetric and analytical methods) 3. Estimate the dosage of chlorine for a domestic water supply and determine the breakpoint chlorination 4. Performance efficiency of a filter bed media (determine the suitable physio-chemical parameters using volumetric and analytical methods)	**30 Hours**

5. Performance studies of Type – I and Type – II settling
6. Determine the kinetic constants of batch adsorption studies by isothermal curves for a dyeing effluent
7. Performance efficiency of a Water softener (determine the suitable physio-chemical parameters using volumetric and analytical methods)
8. Determine the kinetic coefficient on biological growth under different phases
9. Determination of Sludge Volume Index based on the MLSS/MLVSS concentration
10. Performance of Advanced Oxidation process using Photo-catalysis (determine the suitable physio-chemical parameters using volumetric and analytical methods)

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
0	0	30	0	30

Learning Resources:

Textbooks:

1. Metcalf & Eddy, Inc. Wastewater Engineering: Treatment and Reuse. 4th Edition. McGraw- Hill, New York, NY. 2003.
2. Sawyer, C.N., McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineering 5th Edition. Tata McGraw-Hill Publishing Company Limited. 2003.
3. Weber Jr., W.J., Physico-chemical Process for Water Quality Control. Wiley Inc. Newyork, 1972.
4. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, Indian edition, 2017.

Reference books

1. AEESP Environmental Processes Laboratory Manual, Association of Environmental Engineering and Science Professors Foundation, Washington, 6th Ed. 2002.
2. APHA, AWWA, WEF. Standard Methods for Examination of water and wastewater. 22nd Ed. Washington: American Public Health Association; 2012.
3. CPHEEO, "Manual on Municipal Solid waste management, Vol I, II and III, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2016.
4. Lee, C.C. and Shundar Lin. Handbook of Environmental Engineering Calculations, 2nd Ed. Mc Graw Hill, New York, 2007

Online Resources (Weblinks)

1. https://nepis.epa.gov/
2. https://www.organomation.com/environmental-sample-preparation
3. https://www.health.nsw.gov.au/environment/factsheets/Pages/breakpoint-chlorination.aspx
4. https://www.cs.montana.edu/webworks/projects/stevesbook/contents/chapters/chapter002/section002/black/page001.html

Assessment (Practical course)

Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr.A. Geethakarthi, Department of Civil Engineering

Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

SEMESTER II

24ENT506	Environmental Impact Assessment And LCA	L	T	P	J	C
		3	0	0	0	3
PC		SDG	7, 14, 15			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	learn the need, methodology, documentation and usefulness of environmental impact assessment
2	develop the skill to prepare environmental management plan
3	understand the methodology of Life Cycle Assessment (LCA) as per international standards
4	develop sustainable products and promote sustainable consumption

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	classify the need of EIA/EIS process and regulatory aspects	U
CO2	implement appropriate methodologies for environmental impact prediction and assessment	Ap
CO3	quantify and mitigate the environmental impacts on various ecosystem (land, air, water) and their Socio-Economic Aspects	Ap
CO4	evaluate the elements of Life Cycle Assessment of Products and services complying to international environmental management system standards	An
CO5	categorize and validate inventory LCA data models	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3			3	3
2	3	3	3	3	3	3
3	3	3			3	3
4	3	3		2	2	
5	2	3	3			

Course Content

INTRODUCTION EIA Definition - Historical development and need for Environmental Impact Assessment (EIA) – Environmental Impact Statement (EIS) – EIA in project cycle - Capability and limitations – Legal and Regulatory aspects in India – EIA process - Types and Stages of EIA – MoEF guidelines for performing EIA of development projects - Cross sectoral issues and terms of reference in EIA – Public Participation in EIA	**9 Hours**

IMPACT IDENTIFICATION AND PREDICTION Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modelling for impact prediction – Assessment of impacts – air, water, soil, noise, biological, social & cultural activities and on flora & fauna- Mathematical models- Public participation - Cumulative Impact Assessment	**9 Hours**
SOCIAL IMPACT ASSESSMENT, EMP AND EIA DOCUMENTATION Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition - Environmental Management Plan - preparation, implementation and review - Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Case studies - Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation	**9 Hours**
LIFE CYCLE ANAYSIS AND ASSESSMENT Scope of Life Cycle analysis - analytical tools for product and service systems – History and definition of LCA - International organizations and networks - The ISO 14040 framework - Life cycle of Products and services – Industrial ecology - Impacts & value creation along the life cycle –Life cycle management (LCM) and Stakeholder Expectations – LCM drivers and issues materials flow analysis –technical characteristics – Life cycle goal and scope definition - function, functional unit and reference flow	**9 Hours**
INVENTORY AND IMPACT ANAYSIS System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Dealing with Allocation Issues - Solutions to the multifunctionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI - LCA softwares and database - Data quality - Data collection and relating data to unit processes -Data validation - Cut-off and data estimation - Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification - Characterization - Optional elements -normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources:

Textbooks:

1. Canter R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
2. Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Commonwealth Publishers, New Delhi, 1992.
3. Marry Ann Curan, Environmental Life Cycle Assessment, Mc Graw Hill New York 1996
4. International Organization for Standardization: ISO 14040 series of Standards for Life Cycle Analysis, 1997 3. Wimmer W, Zust R, Lee K. Ecodesign Implementation: A systematic guidance to integrating environmental considerations into product development. Springer, 2004

Reference books

1. Environmental Assessment Source book", Vol. I, II & III. The World Bank, Washington, D.C., 1991.
2. John G. Rau and David C Hooten "Environmental Impact Analysis Handbook", McGraw Hill Book Company, 1990.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I & II", Blackwell Science, 1999.

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution		Internal Expert(s)
			Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENT507	Nanotechnology in Environmental Engineering	L	T	P	J	C
		3	0	0	0	3
PC		SDG	9			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	understand the synthesis and fabrication and characteristics of nanomaterials
2	synthesis and apply nanotechnology in diverse research and industrial fields and to access their impacts onto the environment
3	learn the principles of nano- catalysis, membranes, nanofiltration and other methods in the processes of water treatment processes

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	identify and understand various approaches for nanomaterial synthesis	U
CO2	characterize and analyse the synthesized nanomaterials	Ap
CO3	synthesize and characterize nano-membrane and nanomaterial	An
CO4	identify the impact of nanoparticle and its toxicity to the environment	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2			3	2
2	3	2	2		3	2
3	3	2			3	2
4		2	3		3	2

Course Content

Introduction and Synthesis of Nanomaterials History –Overview of existing application of nanomaterials in water and wastewater treatment; Synthesis of nanomaterials: magnetic nanoparticles, Carbonaceous nanoparticles; nanocomposites; clay supported nanoparticles, aerogels- Methods of synthesis: Sol-Gel method, microemulsion method, electrospinning method, plasma technique, Chemical Vapour Deposition (CVD)	**9 Hours**
Methods for Structural and Chemical Characterization of Nanomaterials Separation techniques- Morphology studies: scanning electron microscopy (SEM) - Surface charge and optical properties of nanoparticles: zeta potential, UV-Vis Spectrometry-Elemental composition of single nanoparticles using EDAX, elemental composition of bulk nanoparticles- X-ray diffraction (XRD) – Fourier Transform- Infra red Spectroscopy (FTIR)	**8 Hours**

Nanomembranes Technology Overview of membrane technology- Types of membrane filtration, microfiltration, ultra filtration, nanofiltration, reverse osmosis – Transport principles - Membrane fabrication and characterization- Nanoparticle membrane reactor	**10 Hours**
Nanomaterials as Adsorbents and Oxidants Metals oxides (Titanium oxides, Iron oxides, Copper, Zinc) – Carbon nano-adsorbents: CNTs Carbon nanotubes (single and multiwalled), Fullerenes- Molecularly imprinted polymers for removal of micropollutants- Advanced Oxidation Process: Photocatalytic oxidation, Fenton process	**9 Hours**
Fate and Toxicity of Nanoparticles and Nanomaterials Processes determining the fate of NMs /NPs in environment: aggregation, reaction, adsorption, deposition; ecotoxicity of NMs/NPs; - Effect on human health and environment- Introduction to nanosensors	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources:

Textbooks:

1. Ajay Kumar Mishra, "Application of Nanotechnology in Water Research", Scrivener Publishing LLC. 2014
2. Eugene T, Michele De Kwaadsteniest, "Nanotechnology in Water Treatment Applications", Caister Academic Press, 2010
3. Lens P., Virkutyte J., Jegatheesan V., and Al-Abed S., "Nanotechnology for Water and Wastewater Treatment', IWA Publishing, 201

Reference books & Weblinks:

1. Barai, D. P., Chichghare, K. K., Chawhan, S. S., & Bhanvase, B. A. (2021). *Nanomaterials for En vironm Environmental Engineering and Energy Applications*
2. Biswas, J. K., & Rai, M. (2024). *Nanotechnology for Environmental Management*. Publisher
3. Handbook of Nanotechnology, Edi-Bharat Bhushan, Springer, 2004
4. Ledwani, L., & Sangwai, J. S. (Eds.). (2020). *Nanotechnology for Energy and Environmental Eng ineering*

Online Resources (Weblinks)

1. Nanotechnology and the Environment: Applications and Implications - 575.763 | Hopkins EP Online (jhu.edu)
2. https://www.igmpi.ac.in/nanotechnology
3. https://archive.nptel.ac.in/courses/118/107/118107015/

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**
		Dr. A. Geethakarthi, Department of Civil Engineering

Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENI508	Air and Noise Pollution Control	L	T	P	J	C
		3	0	2	0	4
PC		SDG	6, 11, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	equip students with the knowledge to categorize various sources, types, and nature of air pollut ants
2	enable students to monitor air quality standards and apply different sampling techniques to ens ure accurate data collection and analysis
3	teach students the principles involved in pollutant removal and control measures to effectively mitigate environmental contamination
4	understand the sources and effects of both indoor and outdoor noise pollution, and evaluate me asures for its control and mitigation

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	categorize the various sources, types and nature of air pollutants and their effects on living and non-living beings	Ap
CO2	monitor the air quality standards and the different sampling techniques	Ap
CO3	determine the principle involved in the pollutant removal and their control measures	An
CO4	understand the sources and effects of Indoor and Outdoor Noise Pollution	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3		2	3
2	3		3		2	3
3	3		3		2	3
4	3		3		2	3

Course Content

Sources of Pollution, Ambient Air Quality Standards and Monitoring Definitions - Sources and classification of pollutants - Natural and anthropogenic – Units and measurements - Air quality standards - Meteorology and air pollution - Atmospheric stability and inversions - Mixing height and plume behavior - Effects of air pollution on human beings, vegetation, animals, materials, and climate - Air pollution: Global and Indian scenario with case studies. Industrial and Vehicular sources of air pollution	**9 Hours**
Practical Component:	**2 Hours**

1. Estimation of Air Quality Index	
Sampling, Meteorology and Air Quality Modelling Classification of sampling techniques - monitoring atmospheric pollution - Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability – Adiabatic lapse rate - Wind Rose - Inversion – Wind velocity and turbulence - Plume behaviour - Dispersion of air pollutants - Maximum mixing depth - Dispersion model - Gaussian plume derivation-modifications of Gaussian plume equation - Fixed Box models – Multiple cell models - Estimation of plume rise - Stack design **Practical Component:** 1. Air Sampling techniques and methods – Study Experiment 2. Stack Sampling Techniques and Demonstration of Stack Monitoring kit 3. Demonstration on Wind Monitoring and Analysis of Data for Windrose Diagrams	**9 Hours** **10 Hours**
Air Pollution and Control Measures Source correction methods - Control equipment's - Particulate control methods - Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipments - adsorption and combustion devices: Catalytic combustion – Catalytic oxidation and decomposition. Control technologies for motor vehicles. **Practical Component:** 1. Particulate Sampling – Dust Fall, Pollution Suspended Particulates and Total Particulate Matters using High Volume Sampler 2. Estimating Sulphur Dioxide, NOx in Ambient Air Using High Volume Air Sampler. 3. To Determine Smoke test for Petrol and Diesel Vehicles using Auto Exhaust Analyser	**9 Hours** **10 Hours**
INDOOR AIR POLLUTION Sources types, measurement and control of indoor air pollutants – Equipment Requirement, Volatile Organic Compounds, Inorganic Gaseous Pollutants Respirable Particulates Bioaerosols, Radon and its decay products-Infectious disease transmission-A/C units in indoor- Odours and types of sick building syndrome **Practical Component:** 1. Determine Respirable Dust PM 10 using Respirable Dust Sampler. Determine personal exposure on particulate matter PM 1using cascade impactor	**9 Hours** **4 Hours**
NOISE POLLUTION Sound and noise; sources of noise pollution, environmental and industrial noise; effects of noise pollution: measures for prevention and control of noise; environmental and industrial noise; Noise pollution (regulation & Control) rules, 2000 - noise control legislation - Objectives of control - Source, transmission path, and destination strategies - Outdoor noise propagation - Attenuating factors - Noise control criteria - Vibration control methods. **Practical Component:** 1. Determination of Equivalent noise level. 2. Determination of Light Intensity using Luxmeter	**9 Hours** **4 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 75

Learning Resources:
Textbooks:

1. Ajay Kumar Mishra, “Application of Nanotechnology in Water Research”, Scrivener Publishing LLC. 2014
2. Eugene T, Michele De Kwaadsteniest, “Nanotechnology in Water Treatment Applications”, Caister Academic Press, 2010
3. Lens P., Virkutyte J., Jegatheesan V., and Al-Abed S., “Nanotechnology for Water and Wastewater Treatment’, IWA Publishing, 201

Reference books

1. Barai, D. P., Chichghare, K. K., Chawhan, S. S., & Bhanvase, B. A. (2021). *Nanomaterials for Environm Environmental Engineering and Energy Applications*
2. Biswas, J. K., & Rai, M. (2024). *Nanotechnology for Environmental Management*. Publisher
3. Handbook of Nanotechnology, Edi-Bharat Bhushan, Springer, 2004
4. Ledwani, L., & Sangwai, J. S. (Eds.). (2020). *Nanotechnology for Energy and Environmental Engineering*

Online Resources (Weblinks)

1. Nanotechnology and the Environment: Applications and Implications - 575.763 | Hopkins EP Online (jhu.edu)
2. https://www.igmpi.ac.in/nanotechnology
3. https://archive.nptel.ac.in/courses/118/107/118107015/

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution		Internal Expert(s)
			Dr. A. Gandhimathi, Department of Civil Engineering
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENI509	GIS in Environmental Planning & Management	L	T	P	J	C
		1	0	4	0	3
PC		SDG	11, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	introduce Geographic Information Systems (GIS) with a focus on its applications in environmental planning and management.
2	identify and differentiate between various remote sensing platforms and instruments
3	use GIS software to analyze environmental data, create maps, and support decision-making in various environmental contexts

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand the basic concepts and principles of GIS	R
CO2	apply remote sensing data in GIS software to perform environmental analysis and generate detailed maps.	Ap
CO3	analyze and interpret remote sensing data in different formats to monitor and assess atmospheric, land, and water resources	An
CO4	apply GIS techniques to solve the environmental planning and management problems	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1		3		3	3	3
2		3		3	3	3
3		3		3	3	3
4		3		3	3	3

Course Content

GEOGRAPHICAL INFORMATION SYSTEM Definition- Components of GIS- History and evolution of GIS – GIS application in Environmental Planning. GIS Data Types and Sources – spatial data models – sources of GIS data- Data acquisition and integration.	**3 Hours**
Practical Component: Mapping and Visualization – Cartographic principles and map design- thematic mapping and visualization techniques- creating and interpreting environmental maps	**15 Hours**

REMOTE SENSING Basic Concepts of remote sensing - Electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation - Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS – Scanners, radiometers - Data types and format **Practical Component:** Integration of remote sensing data with GIS – Land use / land cover analysis	**4 Hours** **15 Hours**
DIGITAL IMAGE PROCESSING Satellite Data analysis - Image interpretation: multi-spectral, multi-temporal and multi-sensor **Practical Component:** Digital image processing – Image preprocessing – Image enhancement –Image transformation &fusion - Image classification	**2 Hours** **15 Hours**
APPLICATION WITH GIS Application with Environmental Modelling – hydrology, water quality, and air quality-Scenario and impact analysis- Case studies. Application in EIA – Roles of GIS in EIA-Impact mapping – case studies. Application in Natural Resource management – Land use planning, biodiversity management, water resource management – case studies. **Practical Component:** Overlay analysis, buffer analysis, and proximity analysis-terrain analysis and watershed delineation – spatial interpolation and modelling	**6 Hours** **15 Hours**

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
15	0	60	0	75

Learning Resources:

Textbooks:

1. Bhatta, B, Remote Sensing and GIS, Oxford University Press, 2011
2. Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information systems Oxford University Press, NewYork, 2001.
3. Joseph, G and Jeganathan, C, Fundamentals of reote Sensing, Universities Press, 2018
4. Lillesand, T.M. and Kiefer, R.W, Remote sensing and image interpretation, John Wiley and sons, NewYork, 2004.
5. Lintz, J and Simonet, Remote sensing of Environment, Addison Wesley Publishing Company,New Jersey, 1998

Reference books

1. GIS for Environmental Applications: A Practical Approach by Xuan Zhu (2016)
2. Remote Sensing and GIS for Ecologists: Using Open Source Software by Martin Wegmann, Benjamin Leutner, and Stefan Dech (2014)
3. Geographic Information Systems for Environmental Management by David R. Green (2015)
4. Environmental Modelling: Finding Simplicity in Complexity by David L. Rosgen (1994)
5. GIS for Ecologists: Using Open Source Software by Martin Wegmann, Benjamin Leutner and Stefan Dech (2014)

Online Resources (Weblinks)

1. PG Diploma RS & GIS | Official website of Indian Institute of Remote Sensing, Indian Space Research Organisation, Government of India (iirs.gov.in)
2. MS in Environmental Planning & Management | Hopkins EP Online (jhu.edu)
3. Certified Online GIS Course: Master Environmental Mapping (knowesg.com)
4. Geographic Information Systems PgDip/MSc at Ulster University 2024/25 entry - Full-time Postgraduate Study Online Course

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution		Internal Expert(s)
			Dr. N.Ramsundram, Department of Civil Engineering
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

24ENJ501	Technical Seminar	L	T	P	J	C
		0	0	0	2	1
PRJ		SDG	-			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	encourage the students to explore emerging engineering developments and innovative solutions in the field of environmental engineering
2	inculcate critical thinking using qualitative & quantitative analysis/survey/other technological tools
3	improve drafting and communication skills by preparing and presenting technical reports

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	investigate and interpret specialized topics in Environmental Engineering, demonstrating the ability to evaluate complex systems and emerging challenges.	An
CO2	exhibit expertise and critical discussion with evidence-based reports	Ap
CO3	design and execute professional technical presentations utilizing advanced tools and techniques to communicate findings effectively	E

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	2	2	3	2
2	3	2	2	2	3	2
3	3	3	2	2	2	2

Course Content

Topic Identification • Selection of seminar topics in cutting-edge areas such as water and wastewater treatment, climate change mitigation, renewable energy, environmental impact assessment, etc. • Relevance of topic selection in alignment with UN-SDGs • Guidance on conducting a thorough literature review	**10 Hours**
Research and Preparation • Compilation and organization of technical content • Development of visual aids (PowerPoint, posters, etc.) • Guidance on writing abstracts and preparing detailed reports	**10 Hours**
Seminar Presentation • Delivery of the presentation work to peers and faculty members • Final Seminar Review	**10 Hours**

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	30	Total Hours:	30

Assessment
Presentation, Reviews, viva-voce, Report Submission

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
		Dr. A. Geethakarthi, Department of Civil Engineering	
Recommended by BoS on	13.08.2024		
Academic Council Approval	No: 27	**Date**	24.08.2024

SEMESTER III

24ENJ601	Industrial Training	L	T	P	J	C
		0	0	0	2	2
PRJ		SDG	9,13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	explore real-world challenges and processes in environmental engineering by working closely with industry professionals
2	independently develop solutions for specific environmental engineering challenges by integrating practical skills and insights gained during fieldwork.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand the problems statements and process flow existing in the real time industrial field in the domain of Environmental Engineering	U
CO2	apply the knowledge and participate in solving the prevailing case studies involved in the domain of Environmental Engineering	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1			3	3	3	3
2			3	3	3	3

Course Overview

An industrial training in Environmental Engineering for a minimum of two weeks during the second semester vacation provides students with a crucial opportunity to bridge academic knowledge with practical applications in real-world settings. This mandatory 15-day training, which must be completed individually in a recognized research lab, environmental consulting firm, or industrial field, enables students to develop essential skills in data collection, analysis, and adherence to environmental standards, equipping them for industry requirements. Exposure to industry practices and regulatory standards enhances their readiness for professional roles, encouraging critical thinking and innovative problem-solving as they engage with current environmental challenges. Upon completing the training, students must submit a certification and a comprehensive report during the end-semester viva-voce, which includes sections on Introduction, Literature Survey, Area of Study, Methodology, Data Collection and Interpretation, Results and Discussion, and Conclusion, adhering to a prescribed template. This hands-on experience not only strengthens students' professional credibility but also demonstrates their commitment to the field, ultimately boosting their career prospects.	**30 Hours**

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	30	Total Hours:	30

Assessment (Theory course)
Presentation, Reviews, viva-voce, Report Submission

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
		Dr. A. Geethakarthi, Department of Civil Engineering	
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENJ602	Project Phase-I	L	T	P	J	C
		0	0	0	20	10
PRJ		SDG	9,13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	identify the problem statement aligning the sustainable goals, thereby solving real time problems
2	formulate a research component and methodology through literature survey and gap analysis

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	formulate a research component and methodology through literature survey and gap analysis	An
CO2	use appropriate tools and develop experimental design to solve environmental problems	Ap
CO3	develop presentation and drafting skills to interpret the research findings	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1			3	3	3	3
2			3	3	3	3
3			3	3	3	3

Course Overview

The project work will commence at the start of Semester III as individual project work. The student can undertake a real time problem statement with defined objective choosing an appropriate mentor specialized in his/her area of work. The student can undertake the project in the campus as in-house project or in industry/research laboratories as internships. The expected project outcome shall be a product design, publication or placement in the core or allied field of Environmental Engineering field. The project title shall be theoretical or case studies involving scientific research, design, collection, and analysis of data, determining solutions and must preferably bring out individual contribution. The progress of the project work shall be reviewed under 3 reviews with appropriate rubrics. By the end of the semester, a detailed report stage I should be presented in a standard format, in e-copy/soft bound hard copy as per standard template including Introduction, Literature survey, Methodology, data collection and data interpretation, Result and discussion and conclusion with relevant appendix.	**20 Hours**

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	20	Total Hours:	20

Assessment
Presentation, Reviews, viva-voce, Report Submission

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

SEMESTER IV

24ENJ603	Project Phase-II	L	T	P	J	C
		0	0	0	40	20
PRJ		SDG	-			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	identify the problem statement in addressing and solving real time problems
2	formulate a methodology through literature gaps and experimental works

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	identify gaps in previous research findings and develop an appropriate research methodology	An
CO2	develop experimental design to validate the result interpretation	Ap
CO3	develop the skills in exhibiting the research work for publications and product development	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1			3	3	3	3
2			3	3	3	3
3			3	3	3	3

Course Overview

The project phase – II shall commence at the start of semester IV and shall be in continuation of Project Phase – I project works as in-house or internships. The project shall be individual work of the students with an end outcome as a product, placement and quality publication. The student individually works on a specific topic approved by the head of the division under the guidance of the faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of Environmental Engineering. At the end of the semester, a detailed report stage I should be presented in a standard format, in soft bound hard copy, preferably printed on single side paper, containing the following contents.	**20 Hours**

Theory Hours: 0	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 40	Total Hours: 20

Assessment (Theory course)
Presentation, Reviews, viva-voce, Report Submission

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

PROFESSIONAL ELECTIVES

(TRACK I – INDUSTRIAL DRIVEN ELECTIVE

24ENC001	Cleaner Production and Circular Economy	L	T	P	J	C
		2	0	0	2	3
PE		SDG	3, 9, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	impart foundational knowledge of industrial ecology, sustainability strategies, and pollution prevention techniques to minimize environmental impact across industries
2	equip students with practical skills for conducting cleaner production (CP) assessments, formulating cost-effective solutions, and evaluating circular economy models for sustainable business practices
3	develop analytical competencies in assessing real-world case studies, identifying challenges, and proposing actionable improvements in cleaner production and circular economy implementation.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply the principles of industrial ecology and sustainability strategies and identify specific areas for improvement and sustainability initiatives	Ap
CO 2	implement pollution prevention techniques for process optimization, and material substitution in reducing environmental impact.	Ap
CO 3	prepare comprehensive cleaner production (CP) assessment and recommend cost-effective and environmentally viable solutions.	Ap
CO 4	assess the viability of circular economy business models in achieving long-term sustainability goals for different industries.	An
CO 5	analyze real-world case studies from various industries to identify challenges and opportunities in implementing cleaner production and circular economy models	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3			3
2		3	3	3		
3				3	3	3
4			3		3	3
5	3	3		3		S

Course Content

SUSTAINABLE DEVELOPMENT Sustainable Development-Indicators of Sustainability-Sustainability Strategies Barriers to Sustainability-Industrial activity and Environment-Industrialization and sustainable developmentIndustrial Ecology-Cleaner Production (CP) in Achieving Sustainability-Prevention versus Control of Industrial Pollution-Environmental Policies and Legislations-Regulations to Encourage Pollution Prevention and Cleaner Production-Regulatory versus Market Based Approaches.	**9 Hours**
POLLUTION PREVENTION Definition-Importance-Historical Evolution-Benefits-Promotion-Barriers-Role of Industry, Government and Institutions - Environmental Management Hierarchy Source Reduction Techniques-Process and equipment optimization, reuse, recovery, recycle, raw material substitution-Internet Information and Other CP Resources.	**9 Hours**
CONCEPT OF CLEANER PRODUCTION Overview of CP Assessment Steps and skills, preparing for the site visit, Information Gathering, and process flow diagram, material balance, CP Option Generation Technical and Environmental feasibility analysis valuation of alternatives total cost analysis-CP Financing Establishing a program-Organizing a program preparing a program plan-Measuring progress prevention and cleaner production Awareness plan -Waste environmental	**11 Hours**
Circular Economy Definition and principles of Circular Economy (CE)-Key differences between linear economy and circular economy-Historical context and evolution of the circular economy concept-Global relevance and importance of CE in sustainable development- Circular Economy Models and Strategies -Key models of circular economy: Cradle to Cradle, Regenerative Design, and Industrial Ecology-The 5R approach: Reduce, Reuse, Recycle, Repair, and Refurbish Design for circularity: Principles and practices-Business models supporting CE: Product as a service, sharing economy, and closed-loop supply chains	**9 Hours**
CASE STUDIES Industrial Application of CP Case Studies and Applications of Circular Economy Real-world case studies from various industries Circular economy in cities and communities' Successful business examples implementing circular economy models Analysis of challenges and opportunities in transitioning to a circular economy	**7 Hours**

Theory Hours:	**30**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**60**	**Total Hours:**	**90**

Learning Resources

Textbooks:

References:

1. Paul LBishop, Pollution Prevention Fundamental and Practice, McGraw-Hill International, 2000.
2. World Bank Group, Pollution Prevention and Abatement Handbook-Towards Cleaner Production, World Bank and UNEP, Washington D.C, 2005.
3. Prasad modak, C.Visvanathan and Mandarparasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 2005.
4. Website: UNEP Cleaner Production

Online Resources (Weblinks)

1. Ellen MacArthur Foundation-Website: https://www.ellenmacarthurfoundation.org/
2. Circular Economy Club (CEC) Website: https://www.circulareconomyclub.com/
3. World Economic Forum – Circular Economy Website: https://www.weforum.org/agenda/archive/circular-economy/

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. B. Nithyalakshmi, Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENC002	Environmental Economics and Legislation	L	T	P	J	C
		2	0	0	2	3
PE		SDG				

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	provide a comprehensive understanding of economic theories and their application in analyzing and addressing environmental issues
2	equip students with the ability to apply environmental valuation methods, implement market-based instruments, and develop legal strategies for effective environmental protection
3	foster critical thinking and analytical skills in assessing stakeholder roles and evaluating policy frameworks for sustainable environmental decision-making

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply economic theories to analyze environmental issues	Ap
CO 2	Co-relate environmental valuation methods for policy evaluation	U
CO 3	implement market-based instruments to promote environmental protection	Ap
CO 4	develop legal and institutional compliance strategies for environmental protection	Ap
CO 5	assess the role of stakeholders in environmental decision-making co/po mapping	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3			3
2	3	3	3	3	3	
3		3		3	3	3
4			3		3	3
5	3	3		3		

Course Content

Introduction to Environmental Economics Definition and Scope of Environmental Economics-Relationship between the economy and the environment. -Economic theories applied to environmental issues. Market Failures and Environmental Problems- Public goods, externalities, and the concept of the Tragedy of the Commons. - Market failure in natural resource management	**6 Hours**

Project Components • Conduct a case study on externalities (e.g., air pollution) and suggest policy interventions to correct the market failure • Analyze data on water or air pollution and calculate the social cost using economic theories	**6 Hours**
Role of Economics in Environmental Decision Making Environmental Valuation Methods - Cost-Benefit Analysis (CBA) in environmental policy. Use of CBA in evaluating environmental policies and projects. Taxes, subsidies, and tradable permits. Case studies: Carbon pricing, pollution taxes, and emission trading systems. The Economics of Natural Resource Management-Sustainable use of renewable and non-renewable resources. Resource depletion and conservation economics. **Project Components** • Perform a CBA on a local environmental project (e.g., solid waste management) and assess its economic feasibility • Simulate a cap-and-trade system for carbon emissions, allowing students to trade credits and analyze market behaviour	**6 Hours** **6 Hours**
Introduction of Environmental Legislation and Policy Framework Indian Constitution and Environmental Protection – National Environmental policies- India's commitments under international conventions (Paris Agreement, Rio Summit, etc.).– Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto Agreement, Rio declaration– Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)- The Role of Government and International Organization **Project Components** • Analyze key features of the Environmental Protection Act (EPA) and the Paris Agreement, identifying their impacts on industry • Prepare a compliance checklist for an industrial facility in accordance with the Air (P&CP) and Water (P&CP) Acts	**6 Hours** **6 Hours**
WATER (P&CP) ACT, 1974 and AIR (P&CP) ACT, 1981 Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation. **Project Components** • Simulate the process of obtaining consent to operate under the Water Act, including documentation and legal requirements • Review a real-world case where industries violated the Water or Air Act and present legal remedies and outcomes	**6 Hours** **6 Hours**
ENVIRONMENT (PROTECTION) ACT 1986 and other Acts Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules - responsibilities of generators and role of Pollution Control Boards- Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases. Environmental Impact Assessment (EIA) and Public Participation- Role of NGOs and Public in Environmental Decision-making-Green Tribunal and their role-Case studies	**6 Hours**

Project Components • Simulate the process of obtaining consent to operate under the Water Act, including documentation and legal requirements • Analyze landmark Supreme Court judgments on environmental protection (e.g., Vellore Citizens Welfare Forum case)	**6 Hours**

Theory		Tutorial		Practical		Project		Total	
Hours:	**30**	**Hours:**	**0**	**Hours:**	**0**	**Hours:**	**60**	**Hours:**	**90**

Learning Resources

Textbooks:

References:

1. "Environmental Economics: Theory and Applications" Author: S. Sankaran Year: 2016 Margham Publication, Chennai
2. "Environmental Economics and Sustainable Development" Author: K. K. Sharma Year: 2014 Publisher: Atlantic Publishers & Distributors New Delhi
3. "Environmental Economics: An Introduction" Authors: Barry C. Field and Martha K. Field Year: 2016 (8th Edition) Publisher: Pearson: Boston, MA, USA
4. "Handbook of Environmental Economics" (Vol. 1 & 2) Editors: Karl-Goran Maler and Jeffrey R. Vincent Year: 2003 Publisher: Elsevier, Amsterdam, Netherlands
5. "Environmental Economics and Policy" Author: Charles D. Kolstad Year: 2010 (2nd Edition) Publisher: Oxford University Press: New York, USA
6. Vig, N. J. and Kraft, M. E. "Environmental Policy: New Directions for the Twenty-First Century", 8th edition, CQ Press, 2013.

Online Resources (Weblinks)

1. Ministry of Environment, Forest and Climate Change (MoEFCC): http://moef.gov.in/
2. Central Pollution Control Board (CPCB): https://cpcb.nic.in/
3. National Green Tribunal (NGT): https://greentribunal.gov.in/
4. Environmental Law and Policy Resource Center (ELPRC): https://www.elprc.org/
5. Centre for Science and Environment (CSE): https://www.cseindia.org/
6. Indian Institute of Public Administration (IIPA): https://www.iipa.org.in/
7. The Energy and Resources Institute (TERI): https://www.teriin.org/
8. Indian Council for Environmental Research and Education (ICERE): https://www.icere.org/
9. Environmental Protection Act, 1986 – India: https://www.indiacode.nic.in/handle/123456789/1538?view_type=browse&sam_handle=123456789/1362
10. National Institute of Public Finance and Policy (NIPFP): https://www.nipfp.org.in/

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. B. Nithyalakshmi, Dr. A. Geethakarthi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENC003	Environmental Analysis: Techniques and Instrumentation	L	T	P	J	C
		2	0	0	2	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	develop an understanding of the range and theories of instrumental methods available in analytical chemistry by appropriate selection of instruments for the successful analysis of complex mixtures, reviewing and reporting experiments.
2	develop a skill in installing indigenous analytical techniques with sensor application for monitoring Air, Water, Soil, Solid and Noise quality parameters

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	classify principle mechanism and limitations of analytical instruments	U
CO 2	perform experiments using analytical instruments in water quality monitoring	U
CO 3	apply analytic techniques in wastewater quality monitoring	Ap
CO 4	develop flow measuring devices using sensors and instruments for air quality monitoring	Ap
CO 5	identify the analytical techniques for various pollution management	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3
5	3	2	3			3

Course Content

INTRODUCTION Necessity of Instrumentation & Control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.	**6 Hours**
Project components	**6 Hours**

• Analyze air quality by identifying volatile organic compounds (VOCs) using gas chromatography • Calibrate a UV analyzer to measure particulate matter and interpret the data	
WATER QUALITY PARAMETERS Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Ground water monitoring: Instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution. Instrumentation for site safety and rapid detection of organics in the field **Project components** • Use pH and conductivity analyzers to assess the quality of groundwater samples • Conduct field testing with a thermal conductivity detector to identify groundwater contamination	**6 Hours** **6 Hours**
WASTEWATER MONITORING Automatic wastewater sampling, optimum wastewater sampling locations, and wastewater measurement techniques. Instrumentation set up for wastewater treatment plant. Latest methods of wastewater treatment plants **Project components** • Set up an automatic wastewater sampler and evaluate sampling accuracy at various points. • Use advanced sensors to monitor key parameters (e.g., BOD, COD) during wastewater treatment	**6 Hours** **6 Hours**
AIR MONITORING AND FLOW MEASUREMENTS Measurement of ambient air quality. Flow monitoring: Air flow measurement, gas flow, non- open channel flow measurement, open channel wastewater flow measurement. Rainwater harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water **Project components** • Use air quality sensors to measure pollutants (e.g., NOx, SOx) in ambient conditions • Perform open-channel flow measurements with ultrasonic sensors and analyze results	**6 Hours** **6 Hours**
POLLUTION MANAGEMENT Types and methods of Analysis and Techniques - Pollution Management: Management of radioactive pollutants, Noise level measurement - techniques, Noise pollution and its effects, Solid waste management techniques, social and political involvement in the pollution management system **Project components** • Measure noise levels in different environments and assess compliance with legal standards • Perform physical and chemical characterization of solid waste samples to guide management strategies	**6 Hours** **6 Hours**

Theory Hours: 30	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 60	Total Hours: 90

Learning Resources
Textbooks:
1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.

2. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 2007.
3. Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier, 2007.
4. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
5. Wesley Eckenfelder W.,“Industrial Water Pollution Control”, Second Edition, Mc Graw Hill,1989.

References:

1. Randy D. Down and Jay H. Lehr, Environmental Instrumentation & Analysis Handbook, JohnWiley & Sons.
2. Skoog, Holler, Nieman, Principles of Instrumental Analysis by, Thomson books- cole publications, 6th Ed., 2006.

Online Resources (Weblinks)

1. Industrial Wastewater Treatment - Course (nptel.ac.in)
2. Wastewater Treatment Fundamentals Courses (wef.org)
3. Wastewater Treatment Fundamentals Courses (wef.org)

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. A. Geethakarthi, Dr.B.Nithyalakshmi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENC004	Environmental Audit & Life Cycle Assessment	L	T	P	J	C
		2	0	0	2	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	impart an understanding of systems approach to Environmental Management as per ISO 14001 and skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.
2	includes the conceptual understanding and methodology of Life Cycle Assessment (LCA) as per international standards, its potential applications to develop sustainable products and promote sustainable consumption

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	interpret the strategies and technologies towards sustainable development and their legislation	U
CO 2	develop and evaluate methods within Environmental Management Systems (EMS) as per IS standards	U
CO 3	appreciate the elements of Life Cycle Assessment of Products and services complying to international environmental management system standards	Ap
CO 4	categorize and validate inventory LCA data models	Ap
CO 5	implement product and policy development as the guidelines of international standards	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3
5	3	2	3			3

Course Content

SUSTAINABLE DEVELOPMENT Sustainable Development-Indicators of Sustainability-Sustainability Strategies Barriers to Sustainability-Industrial activity and Environment-Industrialization and sustainable development- -Environmental Policies and Legislations Sustainable Development-	**6 Hours**

Indicators of Sustainability-Sustainability Strategies Barriers to Sustainability-Industrial activity and Environment-Industrialization and sustainable development- - Environmental Policies and Legislations **Project Component:** Identifying sustainability indicators, evaluating environmental risks, and preparing impact reports for a industrial process or campus activity	**6 Hours**
ENVIRONMENTAL MANAGEMENT SYSTEMS Environmental Management Audit Systems (EMAS), ISO 14000 - EMS as per ISO 14001–Framework and Approach for developing an Environmental Management System. Structure and responsibility - Legal and compliance requirements –Eco labelling - Environmental performance indicators and their evaluation – Non-conformance – Corrective and preventive actions -compliance audits – waste audits and waste minimization planning – Environmental statement (form V) **Project Components:** • Prepare an Environmental Management System audit checklist based on ISO 14001 standards. • Evaluate the life cycle of a consumer product and determine eligibility for eco-labeling.	**6 Hours** **6 Hours**
LIFE CYCLE ANALYSIS AND ASSESSMENT Scope of Life Cycle analysis - analytical tools for product and service systems – History and definition of LCA - International organizations and networks - The ISO 14040 framework - Life cycle of Products and services – Industrial ecology - Impacts & value creation along the life cycle –Life cycle management (LCM) and Stakeholder Expectations – LCM drivers and issues materials flow analysis –technical characteristics – Life cycle goal and scope definition - function, functional unit and reference flow **Project Components:** • Collect and compile data on raw material inputs, energy consumption, and waste outputs for a consumer product • Using analytical tools, generating life cycle reports, and interpreting ISO 14040 guidelines	**6 Hours** **6 Hours**
INVENTORY AND IMPACT ANAYSIS System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Dealing with Allocation Issues - Solutions to the multifunctionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI - LCA software and database - Data quality - Data collection and relating data to unit processes -Data validation - Cut-off and data estimation - Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification - Characterization - Optional elements -normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies **Project Components:** • Perform impact characterization of a manufacturing process using the midpoint and endpoint approaches • Compare the environmental impact of plastic, glass, and aluminum packaging using LCA software	**6 Hours** **6 Hours**
LCA CASE STUDIES LCA case studies on Product Design, Product Improvement, Product Comparison and Policy development **Project Components:**	**6 Hours** **6 Hours**

• Analyze and present the environmental impact of a solar power system through an LCA framework • Evaluate the feasibility of adopting circular economy principles in an industrial process	

Theory Hours:	30	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	60	Total Hours:	90

Learning Resources

Textbooks:

1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.
2. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 2007.
3. Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier, 2007.
4. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
5. Wesley Eckenfelder W.,“Industrial Water Pollution Control”, Second Edition, Mc Graw Hill, 1989.

References:

1. Christopher Sheldon and Mark Yoxon, “Installing Environmental management Systems – a step by step guide” Earthscan Publications Ltd, London, 1999.
2. ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2004
3. Paul L Bishop “Pollution Prevention: Fundamentals and Practice”, McGraw- Hill International, Boston,2000.
4. Marry Ann Curan, Environmental Life Cycle Assessment, Mc Graw Hill New York 1996
5. International Organization for Standardization: ISO 14040 series of Standards for Life Cycle Analysis , 1997 3. Wimmer W, Zust R, Lee K . Ecodesign Implementation: A systematic guidance to integrating environmental considerations into product development. Springer, 2004

Online Resources (Weblinks)

1. Industrial Wastewater Treatment - Course (nptel.ac.in)
2. Wastewater Treatment Fundamentals Courses (wef.org)
3. Wastewater Treatment Fundamentals Courses (wef.org)

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. A. Geethakarthi, Dr.B.Nithyalakshmi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENC005	Environmental Social Governance	L	T	P	J	C
		2	0	0	2	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	learn the principles and frameworks of Environmental, Social, and Governance (ESG) to understand their impact on sustainable business practices
2	solve the environmental risks, corporate responsibilities, and sustainability practices to ensure compliance with global standards
3	imbibe social responsibility and community engagement in framing strategies and decision-making processes

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	analyze the core principles of Environmental, Social, and Governance (ESG) and their role in sustainable business practices	An
CO2	evaluate ESG frameworks, regulatory standards, and their applications in corporate governance	An
CO3	design and implement effective ESG strategies addressing	Ap
CO4	assess and interpret ESG performance metrics and their implications for long-term business sustainability	An
CO5	develop comprehensive ESG strategies and assess future trends for long-term organizational sustainability	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3	1		
2	3		3	2	3	2
3	2	3		2	2	3
4		1	2	3	3	
5	3	3	3		3	3

Course Content

Introduction	6 Hours
Definition and Scope of ESG - Evolution and History of ESG - Importance of ESG in Sustainable Development - Global ESG Frameworks and Standards - UN Sustainable Development Goals (SDGs) - Global Reporting Initiative (GRI) - Task Force on Climate-Related Financial Disclosures (TCFD) - ESG and Corporate Responsibility - Ethical Business Practices - Stakeholder Engagement and Transparency - Regulatory	

Environment and Compliance - National and International Regulations - ESG Compliance and Reporting Standards **Project Components:** 1. Conduct a comparative analysis of ESG frameworks (e.g., GRI vs. TCFD) 2. Evaluate a company's ESG report for compliance with global standards 3. Map stakeholder engagement strategies for a case study company	**6 Hours**
Environmental Aspects of ESG Environmental Sustainability and Corporate Responsibility - Carbon Footprint and Climate Change Mitigation - Renewable Energy and Resource Management - Environmental Risk Assessment and Management - Identifying and Mitigating Environmental Risks - Case Studies on Corporate Environmental Initiatives - Sustainable Supply Chains - Life Cycle Assessment (LCA) - Circular Economy Principles **Project Components:** 1. Perform a carbon footprint assessment for a selected organization 2. Analyze environmental risk factors from a corporate sustainability report 3. Design a circular economy model for a chosen product lifecycle	**6 Hours** **6 Hours**
Social Aspects of ESG Social Responsibility and Business Ethics - Corporate Social Responsibility (CSR) Strategies - Case Studies on Successful CSR Initiatives - Diversity, Equity, and Inclusion (DEI) - Policies and Best Practices - Impact on Business Performance. Human Rights and Labor Standards - International Labor Organization (ILO) Guidelines - Ethical Supply Chains. Community Engagement - Social Impact Assessment - Community Investment Strategies **Project Components:** 1. Evaluate the DEI policies of a multinational corporation 2. Design a social impact assessment for a local business initiative 3. Develop a CSR policy proposal for a hypothetical company	**6 Hours** **6 Hours**
Governance Aspects of ESG Corporate Governance Framework - Principles of Good Governance - Board Structures and ESG Oversight. ESG Data Governance and Reporting - Data Collection and Management - ESG Performance Metrics and Reporting. Ethical Leadership and Decision-Making - Corporate Integrity and Anti-Corruption Policies - Shareholder Rights and Engagement. Legal and Regulatory Compliance - Corporate Governance Codes - ESG Risk Management Frameworks **Project Components:** 1. Draft a corporate governance policy addressing ESG criteria 2. Analyze ESG data governance practices from a public company's report 3. Design an ethical decision-making framework for a business case	**6 Hours** **6 Hours**
ESG Strategy, Implementation, and Future Trends Developing and Implementing ESG Strategies - ESG Policy Design and Execution - Integrating ESG into Business Models. Impact Measurement and Benchmarking - ESG Rating Systems and Indexes - Performance Tracking and Continuous Improvement. Innovations and Emerging Trends - Technology and ESG (AI, Blockchain) - Future Policy Developments and Global Trends. Case Studies and Best Practices - Industry-Specific ESG Strategies - Lessons from Leading ESG Performers **Project Components:** 1. Formulate an ESG implementation plan for a medium-scale business 2. Benchmark ESG performance using real-world data from industry leaders 3. Evaluate future ESG trends and draft a strategic response plan	**6 Hours** **6 Hours**

Theory Hours:	30	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	60	Total Hours:	90

Learning Resources:

Textbooks:

1. Eccles, R. G., & Serafeim, G. (2022). *Purpose and Profit: How Business Can Lift Up the World.* Harper Business.
2. Friede, G. (2020). *ESG Investing: Practices, Progress, and Challenges.* Springer.
3. Chatterji, A., Levine, D., & Toffel, M. (2016). *Do Corporate Social Responsibility Practices Reflect Stakeholder Interests?* Harvard Business Review Press.
4. Ameer, R. (2022). *Sustainable Finance and ESG: The Principles of Responsible Investment.* Wiley.
5. Hems, L. (2023). *Governance for Sustainability: Navigating the ESG Landscape.* Palgrave Macmillan.

Reference books & Weblinks:

1. Eccles, R. G., & Krzus, M. P. (2018). *The Integrated Reporting Movement: Meaning, Momentum, Motives, and Materiality.* Wiley.
2. Ghosh, S. (2021). *Sustainability and ESG Reporting.* Routledge.
3. Kell, G. (2018). *Sustainable Investing: Revolutions in Theory and Practice.* Routledge.
4. Freeman, R. E., & Dmytriyev, S. (2021). *Stakeholder Capitalism and ESG.* Springer.
5. Hoffman, A. J. (2022). *Business and the Natural Environment: A Research Overview.* Routledge.

Online Resources:

1. Global Reporting Initiative (GRI): https://www.globalreporting.org
2. Task Force on Climate-related Financial Disclosures (TCFD): https://www.fsb-tcfd.org
3. United Nations Sustainable Development Goals (SDGs): https://sdgs.un.org/goals
4. Principles for Responsible Investment (PRI): https://www.unpri.org
5. Corporate Governance Institute: https://www.thecorporategovernanceinstitute.com

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on		
Academic Council Approval	No:	**Date**

24ENC006	Occupational Health & Safety	L	T	P	J	C
		2	0	0	2	3
PE		SDG	8, 9, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	educate the students interrelatedness of public health, management, employees, and the government to the goals of occupational health and safety.
2	identify a conceptual framework for the practice of occupational health and safety for the prevention of occupational health and safety problems

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	incorporate the health and safety systems by the legal code and practice	Ap
CO 2	categorize and monitor the health hazards and risks	U
CO 3	implement satisfactory and safe design of work premises	Ap
CO 4	assess the plant safety and control techniques	An
CO 5	analyze the impact of occupational hazard in Environmental health and safety management	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3			3
2	3	2	3	3	3	3
3	3		3		2	3
4	3	3	3	3		3
5	3	3	3	3	3	3

Course Content

INTRODUCTION — **6 Hours**

Need for developing Environment, Health and Safety systems in workplaces - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and workplace

Project Components: — **6 Hours**

- Analyze a real or simulated workplace accident, identify root causes, and suggest preventive measures
- Conduct an ergonomic assessment of a workstation to identify risk factors for

musculoskeletal disorders (MSDs)	
OCCUPATIONAL HEALTH AND HYGIENE Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress. **Project Components:** • Measure particulate matter (PM) levels in a selected workplace and compare them with occupational exposure limits • Measure noise levels in different sections of a workplace and recommend noise control strategies	**6 Hours** **6 Hours**
WORKPLACE SAFETY AND SAFETY SYSTEMS Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety. **Project Components:** • Conduct a fire safety audit in a simulated environment and evaluate compliance with safety standards • Perform an inspection of electrical equipment for compliance with safety regulations	**6 Hours** **6 Hours**
HAZARDS AND RISK MANAGEMENT Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans. **Project Components:** • Identify hazards and conduct a risk assessment using a risk matrix for a selected industrial process • Simulate and document an emergency response for a chemical spill or fire incident	**6 Hours** **6 Hours**
ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation**.** **Project Components:** • Develop and deliver a safety training program for a specific workplace hazard • Perform an audit to assess compliance with environmental and occupational health regulations	**6 Hours** **6 Hours**

Theory Hours: 30	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 60	Total Hours: 90

Learning Resources

Textbooks:

1. Asfahl, C. R., & Rieske, D. W. (2018). *Industrial safety and health management* (7th ed.). Pearson.
2. Brauer, R. L. (2016). *Safety and health for engineers* (3rd ed.). Wiley.
3. Goetsch, D. L. (2021). *Occupational safety and health for technologists, engineers, and managers* (8th ed.). Pearson.

4. Healey, B. J., & Walker, K. T. (2009). *Introduction to occupational health in public health practice.* Wiley.
5. Plog, B. A., & Quinlan, P. J. (2012). *Fundamentals of industrial hygiene* (6th ed.). National Safety Council.

References:

1. Bill Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach by Culinary and Hospitality Industry Publications Services, 2005.
2. Brian Gallant, The Facility Manager's Guide to Environmental Health and Safety by Government Inst Publ., 2007.
3. Mistry K U, Siddharth Prakashan, Fundamentals of Industrial Safety and Health by 2012
4. Nicholas P. Cheremisinoff and Madelyn L. Graffia, Environmental and Health and Safety Management by William Andrew Inc. NY, 1995.

Online Resources (Weblinks)

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Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. G.L.Sathyamoorthy, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENC007	Rural Water Supply and Onsite Sanitation	L	T	P	J	C
		2	0	0	2	3
PE		SDG	3, 6			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	provide knowledge of rural water supply systems, including methods, challenges, and national initiatives
2	introduce low-cost water treatment techniques and specific contaminant removal methods suitable for rural areas
3	familiarize with rural sanitation practices, ecological sanitation approaches, and sustainable wastewater management systems
4	explore cattle sanitation practices, focusing on housing, waste management, and improving community health in rural settings

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	analyze various rural water supply techniques and choose appropriate methods for different rural contexts	Ap
CO 2	design and implement specific contaminant removal systems that are contextually appropriate for rural water sources.	Ap
CO 3	apply the principles of ecological sanitation to design low-cost, sustainable wastewater treatment and management systems in rural areas.	Ap
CO 4	evaluate the environmental impact of solid waste disposal methods and recommend sustainable practices for rural sanitation.	An
CO 5	implement best practices in cattle sanitation, focusing on housing, manure management, and water supply to improve cattle health and reduce disease transmission in rural communities.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3	3		3	2
2	3	2	3		3	
3	3		3	3	3	3
4	3	2	3		3	3
5	3	3	3	3		3

Course Content

Rural Water Supply:	6 Hours

Issues of rural water supply -Various techniques for rural water supply- merits-National rural drinking water program- rural water quality monitoring and surveillance -operation and maintenance of rural water supplies. Jal Jeevan Mission Department of Drinking Water & Sanitation Ministry of Jal Shakti Reforms in rural drinking water supply - Jal Jeevan Mission (Har Ghar Jal) **Project Components:** • Analyze rural water samples for pH, turbidity, and microbial contamination • Design a basic water supply layout for a rural village considering population and water demand	**6 Hours**
Low-Cost surface/Ground Water Treatment: Introduction - Epidemiological aspects of water quality- methods for low-cost water treatment- Specific contaminant removal systems -Fluoride, Hardness and Disinfection **Project Components:** • Evaluate fluoride removal efficiency using activated alumina or bone char • Design and construct a small-scale sand filter for household water treatment	**6 Hours** **6 Hours**
Rural Sanitation: Introduction to rural sanitation-Community and sanitary latrines-planning of the wastewater collection system in rural areas- Ecological sanitation approach - Grey water and stormwater management - catch basins-constructed wetlands- roughing filters-stabilization ponds - septic tanks-anaerobic baffled reactors-soak pits- low-cost excreta disposal systems Village ponds as sustainable wastewater treatment system-Wastewater disposal - concept of Sulabh Shauchalaya-SBM; Swachh Bharat Mission Toilets **Project Components:** • Design and create a soak pit to manage greywater from rural households • Develop a model of an ecological sanitation system such as a twin-pit latrine	**6 Hours** **6 Hours**
Solid Waste Management: Disposal of Solid Wastes- Composting land filling- incineration- Biogas plants- Other specific issues and problems encountered in rural sanitation. **Project Components:** • Set up a composting system and evaluate the decomposition process • Design a basic biogas plant for rural organic waste management	**6 Hours** **6 Hours**
Cattle Sanitation in Rural Areas: Introduction to Cattle Sanitation-Housing and Shelter Management-Wastewater and Waste Management-Veterinary Care and Community Health Education-Best Practices and Sustainability **Project Components:** • Design a manure management system for a small-scale cattle farm • Analyze water samples from cattle farms for contamination levels	**6 Hours** **6 Hours**

Theory Hours: 30	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 60

Learning Resources

Textbooks:

1. Eulers, V.M.and Steel,EW Municipal and Rural Sanitation, 6th Ed McGraw HillBook Company.
2. Wright, F.B. Rural water Supply and Sanitation, E.Robert Krieger Publishing Company Huntington, New York
3. Juuti, P. Tapio S. Kand Vuorinen H. Environmental History of Water: Global Viewson Community Water Supply and Sanitation, IWA Publishing (IndWater Assoc).

4. Winbald, U and Simpson-Hebert M. Ecological Sanitation SEI Stockholm Sweden.
5. Kadlec R.Hand Wallace S.D.Treatment Wetlands, CRC Press, Boca Raton
6. Wastewater Engineering Treatment and Reuse Metcalf and Eddy, Tata McGraw Hill

References:

1. Mara, D. (2004). *Domestic wastewater treatment in developing countries.* Earthscan Publications.
2. Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2014). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
3. Fewtrell, L., & Bartram, J. (2001). *Water quality: Guidelines, standards, and health.* IWA Publishing.
4. Cairncross, S., & Feachem, R. (2018). *Environmental health engineering in the tropics: Water, sanitation, and disease control* (3rd ed.). Routledge.
5. Rose, J. B., & Jiménez-Cisneros, B. (2019). *Global water pathogen project: Sanitation and health.* Michigan State University Press.

Online Resources (Weblinks)

1. https://jalshakti-ddws.gov.in/national-rural-drinking-water-programme
2. https://jaljeevanmission.gov.in
3. https://jalshakti-ddws.gov.in
4. https://ejalshakti.gov.in/IMISReports/Reports/WaterQuality/rpt_WQMMain.aspx
5. http://nihroorkee.gov.in
6. http://www.cwc.gov.in
7. http://cgwb.gov.in
8. https://swachhbharatmission.gov.in
9. http://www.sulabhinternational.org
10. https://www.ircwash.org
11. https://moef.gov.in
12. https://mnre.gov.in
13. https://dahd.nic.in
14. https://www.nddb.coop
15. https://agricoop.nic.in

Assessment (Embedded course)

SA I and SA II, Activity and Learning Task(s), MCQ, End Semester Examination (ESE), Mini project, Presentation, Reviews, viva-voce, Report Submission

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr.G.L.Sathyamoorthy Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

PROFESSIONAL ELECTIVES

(TRACK II – ADVANCED ELECTIVES)

24ENE008	Advanced Oxidation Process	L	T	P	J	C
		3	0	0	0	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	educate the students to identify the critical issues and challenges that limit the use of conventional treatment processes of water and wastewater.
2	A thorough understanding of the Advanced Oxidation Processes (AOPs) would inculcate knowledge on its application in the removal of contaminants is included in this course

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	comprehend the capabilities and constraints of advanced oxidation processes in water treatment and have knowledge on the design and process operation	U
CO 2	select an appropriate advanced oxidation treatment process	U
CO 3	categorize and synthesis advanced oxidants for suitable treatment process	Ap
CO 4	identify industrial specific pre-treatment, post treatment process including cost-benefit analysis	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3

Course Content

INTRODUCTION TO AOP Introduction to AOPs for water and wastewater treatment – mechanism – photo oxidation reactions – photocatalytic reactions, photo-initiated oxidation – UV- H2O2 / ozonation, fenton / photo-fenton – photocatalysis – light source choice – used in AOPs and their spectral distributions.	**8 Hours**
HETEROGENEOUS PROCESS Introduction to nano & heterogeneous photocatalysis effect of system composition and process. Identification of degradation products, Photoreactors (liquid phase/ gas phase) – solar/ artificial light photo reactors – operation of pilot plants – comparing reactor efficiencies – system design – solar collectors – technology issues – slurry, supported catalyst – reuse – novel photocatalysts, Synthesis methods – bulk, chemical approaches, physical approaches, nanoporous materials – physic chemical methods for characterization of nano materials	**10 Hours**
HOMOGENOUS AOPS	**8 Hours**

Ozone, electro-chemical oxidation, ultrasonication, UV – Photolysis, Hydrogen Peroxide and Ultraviolet Radiation (H2O2/UV), Fenton and Photo Fenton"s Oxidation, chemical and non-chemical AOPs, advantages and disadvantages of homogeneous processes.	
ENHANCEMENT OF QUANTUM YIELD Non-thermal plasma-electron hydraulic cavitation and sonolysis- super water oxidation – γ rays-electron beams, Quantum yield improvement by additional oxidants – hydrogen peroxide persulphate – catalyst modification. case studies and applications semiconductor photolysis. Process fundamentals, applications and commercial process.	**9 Hours**
INDUSTRIAL APPLICATIONS AND ECONOMIC ASSESSMENT OF AOTS Application of AOPs for industries like textile, petroleum pharmaceutical and petrochemical industry. Ground water decontamination – drinking water treatment – pilot & land fill photochemical – cost calculation – economic analysis.	**10 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.
2. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw-Hill companies, 2007.
3. Nelson Leonard Nemerow, "Industrial waste Treatment", Elsevier, 2007.
4. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
5. Wesley Eckenfelder W.,"Industrial Water Pollution Control", Second Edition, Mc Graw Hill, 1989.

References:

1. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" , Imperial College Press, 2004.
2. R.M.Rose, L.A.Shepard and J.Wulff, "The Structure and Properties of Materials", Wiley Eastern Ltd,
3. Simon Parsons, "Advanced oxidation processes for water and wastewater treatment", IWA Publishing, 2004
4. Thomas Oppenländer, "Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts", Wiley-VCH Publishing, Published by, 2003

Online Resources (Weblinks)

1. Industrial Wastewater Treatment - Course (nptel.ac.in)
2. Wastewater Treatment Fundamentals Courses (wef.org)
3. Wastewater Treatment Fundamentals Courses (wef.org)

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. A. Geethakarthi, Dr.B.Nithyalakshmi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

		L	T	P	J	C

24ENE009 PE	Design of Environmental Engineering Structures	3	0	0	0	3
		SDG	9,11			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	educate the structural design principles of structures used in environmental engineering applications, with the help of IS recommendations and computerized tools

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	design concrete and steel pipes	Ap
CO 2	design water retaining structures	Ap
CO 3	design wastewater retaining structures	Ap
CO 4	design bunkers and silos	Ap
CO 5	design structures like underground reservoirs, swimming pools, intake towers, cyclone separator and scrubber.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3	2	3	2
2	3	2	3		3	2
3	3	2	3	2	3	2
4	3	2	3		3	2
5	3		3		3	2

Course Content

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. Structural design of - Concrete, Prestressed Concrete, Steel and Cast-iron piping mains, - anchorage for pipes - massive outfalls	**9 Hours**
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, Filters	**9 Hours**
DESIGN OF WASTEWATER RETAINING STRUCTURES Structural design of wastewater treatment units - Grit chamber, Parshall flume, Aeration tank, Anaerobic baffle reactor, Sludge digester, UASBR, Sludge thickener, Sludge drying beds	**9 Hours**
STORAGE STRUCTURES Design of Square bunker and Storage structures – IS codal provisions – Design of cylindrical silo.	**9 Hours**

Design of various types of foundation like isolated, combined and raft foundation for a Water tanks, Bunkers and Silos	
SPECIAL STRUCTURES Design of masonry walls, pillars and footings as per NBC and IS Codes -Structural design of underground reservoirs and swimming pools, Intake towers - effect of earth pressure and uplift considerations – design of - Cyclone separator – Scrubber	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Varghese, P. C. (2016). Limit State Design of Reinforced Concrete (3rd ed.). PHI Learning Pvt. Ltd.
2. Punmia, B. C., Jain, A. K., & Jain, A. K. (2016). Reinforced Concrete Structures (Vol. 1). Laxmi Publications.
3. Gambhir, M. L. (2014). Design of Reinforced Concrete Structures. PHI Learning Pvt. Ltd.
4. Dayaratnam, P. (2017). Design of Reinforced Concrete Structures (4th ed.). Oxford & IBH Publishing Co.
5. Subramanian, N. (2010). Design of Reinforced Concrete Structures. Oxford University Press.

References:

1. Krishna Raju, "Prestressed Concrete" Tata McGraw Hill Publishing Co. 6th Edition, 2018.
2. Sinha N.C. &. Roy S.K "Reinforced Concrete" S. Chand and Co., 2007.
3. Ramaswamy, G.S., “Design and Construction of Concrete shell roofs", CBS Publishers, India,2005.
4. Green, J.K. and Perkins, P.H., “Concrete liquid retaining structures", Applied Science Publishers, 1980.
5. Rajagopalan K., "Storage structures", Tata McGraw Hill, New Delhi, 2004.
6. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, New Delhi, 2016.

Online Resources (Weblinks)

1. **MIT OpenCourseWare: Civil and Environmental Engineering** https://ocw.mit.edu/courses/civil-and-environmental-engineering/
2. **Coursera: Environmental Engineering Courses** https://www.coursera.org/courses?query=environmental+engineering
3. **Open Educational Resources (OER) for Engineering** https://libguides.humboldt.edu/openedu/engr
4. **ASCE Library (American Society of Civil Engineers)** https://ascelibrary.org/
5. **Introduction to Civil, Architectural, and Environmental Engineering (YouTube)** https://www.youtube.com/watch?v=mEZ9Mbx7jlc

6. Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Mr.KRP. Satheesh Kumar Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE010	Environmental System Analysis	L	T	P	J	C
		3	0	0	0	3
PE		SDG	13, 14, 15			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	introduce the concepts of systems and system approach
2	expose the learner towards solving algorithms that assist decision making in case of a system

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	identify a system and its behaviour	U
CO 2	formulate a system for an Environmental process	Ap
CO 3	Identify and categorize Linear / Non-linear algorithm based on the system constraints	U
CO 4	understand the process or parameters or criteria that may influence a decision	U
CO 5	understand the role of systems in LCA, circular economy and sustainability development	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3		2	3	
2	3	3		2	3	
3	3	3		2	3	
4	3	3		2	3	
5	3	3		2	3	

Course Content

Systems Theory Introduction to system – Types of system- Properties of system – complex system behaviour	**4 Hours**
Systems Approach Establishing objectives, decision variables, constraints for Environmental Engineering Planning & Design; Introduction to Linear and Non-Linear systems	**8 Hours**
Solution Algorithms Linear programming – Slack & Surplus Variables; Non-Linear Programming; Introduction to problem solving using evolutionary algorithms; objective function sensitivity	**13 Hours**
Decision Analysis	**12 Hours**

Multi criteria analysis – solution using alternate objectives- pareto optimality and tradeoffs; Trade evaluation (Environmental, Economic, social criteria) – Cost benefit analysis – Analytical Hierarchy process – matrix method for generating scores and weights.	
Application Introduction to Life Cycle Assessment (LCA) – Stages, Phases and types; Introduction to sustainable development indicators and Circular economy	**8 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Vedula, S., & Mujumdar, P. P. (2005). *Water resources systems*. Tata McGraw-Hill Publishing Company Limited.
2. Imboden, D. M., & Pfenninger, S. (2013). *Introduction to system analysis: Mathematical modeling of natural systems*. Springer.
3. Ravindran, A., Philips, T. D., & Solberg, T. J. (2007). *Operations research: Principles and practice*. Wiley INDIA.
4. Bennett, R. J., & Chorley, R. J. (2015). *Environmental systems: Philosophy, analysis and control*. Princeton University Press.
5. Gray, W. G., & Gray, G. A. (2020). *Environmental systems science: Theory and practical applications*. Academic Press.

References:

1. Vedula S and Mujumdar P P, 2005. “Water Resources Systems”, Tata McGraw-Hill Publishing Company Limited, NewDelhi.
2. Dieter M Imboden and Stefan Pfenninger, 2013. “Introduction to system analysis – Mathematical modeling Natural systems”, Springer.
3. Ravindran A, Philips T Don, and Solberg T James. 2007/ “Operations Research – Principles and Practice”, Wiley INDIA.

Online Resources (Weblinks)

1. University of Michigan School for Environment and Sustainability. (n.d.). *Environmental systems analysis*. Retrieved from https://seas.umich.edu/academics/courses/environmental-systems-analysis
2. EcoBioMOD. (n.d.). *Environmental system analysis*. Retrieved from https://ecobiomod.com/environmental-system-analysis/
3. ESS-DIVE. (n.d.). *Data, modeling, and software resources - Environmental system science*. Retrieved from https://ess.science.energy.gov/data/
4. Routledge. (n.d.). *Environmental modeling & systems analysis books*. Retrieved from https://www.routledge.com/environmental-science/environmental-modeling-systems-analysis
5. SpringerLink. (n.d.). *Environmental systems analysis*. Retrieved from https://link.springer.com/search?query=environmental+systems+analysis

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. B. Nithyalakshmi, Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on		

Academic Council Approval	No:	Date	

24ENE011	Industrial wastewater treatment	L	T	P	J	C
		3	0	0	0	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	impart knowledge on industrial wastewater treatment and residue management
2	understand the principles of various processes applicable to industrial wastewater treatment
3	make the students learn implementation of pollution prevention and waste minimization techniques
4	choose appropriate industrial waste disposal methods and concepts on zero effluent discharge

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand concepts and application of Industrial pollution prevention, cleaner technologies on industrial wastewater treatment	U
CO2	understand principles of various processes applicable to industrial wastewater treatment	U
CO3	implement an overall treatment strategy for industrial wastewater and Residue management	Ap
CO4	estimate capital and operating costs for industrial waste treatment systems	Ap
CO5	analysis of industrial wastewater characteristics from major industry and its Environmental Standards	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3
5	3	2	3			3

Course Content

INTRODUCTION Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – Industrial wastewater monitoring and sampling – generation rates – characterization and variables – Toxicity and Bioassay tests. Effect of Industrial effluents on stream sewer and human health–- Industrial scenario in India – Industrial activity and environment – Uses of water by Industry	**9 Hours**
TREATMENT OF INDUSTRIAL WASTEWATER Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High-Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – management of RO reject - Nutrient removal	**9 Hours**
INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION Prevention vis a vis Control of Industrial Pollution – Benefits and Barriers – Waste Audit - Waste Management Hierarchy - Source reduction techniques – Periodic Waste Minimization Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries	**9 Hours**
DISPOSAL OF TREATED INDUSTRIAL WASTEWATER Individual and Common Effluent Treatment Plants – Advantages – Joint treatment of Industrial and domestic wastewater - zero polluting industry concept –Reduce, Reuse and Recycle of wastewater – Disposal of effluent on land – Quantification, characteristics and disposal of sludge - Present status and issues.	**9 Hours**
CASE STUDIES Industrial manufacturing process description, wastewater characteristics, source reduction points and effluent treatment flow sheet for Sugar, Distilleries, Pulp and Paper mill, Tanneries - Chemical industries – Metal finishing and electroplating industries - Iron and Steel industries - Meat packing industries and Poultry plant – Pharmaceuticals and other Paramedical Industry	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources:

Textbooks:

1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.
2. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw-Hill companies, 2007.
3. Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier, 2007.
4. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
5. Wesley Eckenfelder W.,“Industrial Water Pollution Control”, Second Edition, Mc Graw Hill, 1989.

Reference:

1. Lawrance K.Wang, Yung Tse Hung, Howard H.Lo and Constantine Yapijakis “handbook of Industrial and Hazardous waste Treatment”, Second Edition, 2004.
2. Patwardhan, A. D. (2017). *Industrial Wastewater Treatment*. PHI Learning Pvt. Ltd
3. Ranade, V. V., & Bhandari, V. M. (2014). *Industrial Wastewater Treatment, Recycling and Reuse* Butterworth-Heinemann
4. Sonawane, S. H., Setty, Y. P., Narsaiah, T. B., & Naik, S. S. (2018). *Innovative Technologies for the treatment of Industrial wastewater. A sustainable approach.* Apple Academic Press.

Online Resources (Weblinks)

1. Industrial Wastewater Treatment - Course (nptel.ac.in)
2. Wastewater Treatment Fundamentals Courses (wef.org)
3. Wastewater Treatment Fundamentals Courses (wef.org)

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. A. Geethakarthi, Dr.B.Nithyalakshmi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE012	Landfill techniques and site remediation	L	T	P	J	C
		3	0	0	0	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	understand the important characteristics and design principles of the waste containment facility and remediation of contaminated site
2	learn the relevant regulations and engineering design requirements of landfills and contaminated site remediation

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	have an overview of the Indian and international landfill regulations and guidelines for the design, construction, operation and management of landfills	U
CO 2	understand the design and construction of landfills, processes in landfills, methods for management and treatment of landfill gas and leachate	U
CO 3	have an in-depth understanding of the key pollutants in leachate and gas, their potential environmental impacts and the engineering design and performance of control systems used to manage and treat pollutant and waste emissions from sites.	Ap
CO 4	be able to apply a risk-based assessment of contaminated sites and implement site remediation technologies	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3

Course Content

LANDFILL BASICS Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuaration - Legal framework for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design - Landfill Design Tasks.	**8 Hours**
LANDFILL LINERS AND COVER SYSTEMS	**10 Hours**

Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geosynthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design-liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geomembranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow-advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover -Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control.	
LEACHATE AND LANDFILL GAS MANAGEMENT Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of Landfill Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – Leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems-Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor landfills- monitoring and control of leachate and Landfill gas- Landfill Settlement.	**9 Hours**
LANDFILL OPERATION AND CLOSURE Landfill Construction and Opeartional Controls – Fill Sequencing Plans – Cell Construction- Dozer and Compactor operations-Selection of Landfill Equipment-Landfill Administration-Record Keeping - Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety - Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees.	**8 Hours**
CONTAMINATED SITE REMEDIATION Contaminated sites - Fate and behaviour of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cut-off Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining.	**10 Hours**

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45

Learning Resources

Textbooks:

1. Industrial wastewater management, treatment & disposal, Water Environment, Federation Alexandria Virginia, Third Edition, 2008.
2. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 2007.
3. Nelson Leonard Nemerow, “Industrial waste Treatment”, Elsevier, 2007.
4. Soli. J. Arceivala, Shyam. R. Asolekar, Wastewater Treatment for pollution control and reuse by Tata Mcgraw Hill, 2007
5. Wesley Eckenfelder W.,“Industrial Water Pollution Control”, Second Edition, Mc Graw Hill, 1989.

References:

1. Robert M. Koerner and Donald H Gray (2002), Geotechnical aspects of Landfill Design and Construction, Prentice Hall, New Jersy.

2. Neal Bolton P.E (1995), "The Handbook of Landfill Operations", Blue Ridge Services Inc., Atascadro, CA – ISBN 0-9646956-0-x
3. David E Daniel and Robert M. Koerner (2007), " Waste Containment Facilities –Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, American Socirty of Civil Engineers, ASCE Press.
4. Donald L Wise and Debra J Trantolo (1994), "Remediation of Hazardous Waste Contaminated Soils, Marcel Dekker Inc., New York
5. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.

Online Resources (Weblinks)

1. Industrial Wastewater Treatment - Course (nptel.ac.in)
2. Wastewater Treatment Fundamentals Courses (wef.org)
3. Wastewater Treatment Fundamentals Courses (wef.org)

Assessment (Theory course)
SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
		Dr. V. Gayathri, Department of Civil Engineering	
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE013	Marine Pollution & Control	L	T	P	J	C
		3	0	0	0	3
PE		SDG	13, 14			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	educate the students on aspects of marine pollution and methods of water quality assessment and marine pollution control.
2	acquire knowledge on the effect of marine ecology

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand the marine and coastal environment, their resources and the process.	U
CO 2	identify the sources of marine pollution and access their impact on marine ecology	U
CO 3	assess the various techniques for measuring and monitoring oceanic environment parameters.	Ap
CO 4	understand the legal requirements and legislations involved in marine pollution control	U
CO 5	apply professional ethics in designing solutions to prevent and control marine pollution and lead paths for sustainable development	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3			2
2	3		3			2
3	3	2	3	2		2
4	3		3			
5	3		3	3		2

Course Content

Marine and Coastal Environment and Resources Seas and oceans, Continental area, Coastal zone, Properties of sea water, Principles of Marine Geology, coastal features – Beaches, Estuaries, Lagoons- Wave characteristics and theories - Sediment transport - Tides - Ocean Currents - Thermocline circulation - General circulation of ocean waters, Tsunamis, Storm surge. Living resources - coral reefs, mangroves, sea grass, seaweeds, fishery potential – non-living resources - manganese nodules, heavy minerals - Beaches, Estuaries, Lagoons – Shoreline change	**9 Hours**

Marine Pollution Sources and Effects Sources of Marine Pollution – Point and non-point sources: physical, chemical, biological, thermal, radioactive and non-point; oil and micro-plastic pollution; Pollution caused by Oil Exploration and spillage, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems – Marine discharges and effluent standards. Oceanographic factors involved in dispersing pollutants; the transport phenomenon; advective and diffusion aspects; dispersal of pollutants in estuaries and near shore areas; Impacts of pollution on marine resources	**9 Hours**
Legal Aspects and Regulations of Marine Pollution Control The Environment (Protection) Act, 1986 – Definitions, General Powers of the Central Government, Prevention, Control and Abatement of Environmental Pollution, and Miscellaneous provisions. Maritime Conventions relating to maritime environment and prevention and control of marine pollution ratified by India, National and International treaties, protocols in marine pollution - Exclusive Economic Zone, The Law of the Sea and Marine pollution, International Convention for the prevention of pollution from Ships (MARPOL) International Convention on Oil Pollution preparedness, response and Cooperation (OPRC) , Other conventions and enforcement.	**9 Hours**
Marine Pollution Monitoring Toxicity and types of toxicity tests - Use of analytical instruments AAS, ICP, GLC, and Spectrofluorometer for analyzing Petroleum hydrocarbon, Pesticides, Heavy metals etc., Basic measurements - Sounding boat, lead lines, echo sounders – current meters - tide gauge – use of GPS – Measurement of coastal water characteristics – sea bed sampling – Modeling of Pollutant transport and dispersion - Oil Spill Models - Ocean Monitoring satellites – Applications of Remote Sensing and GIS in monitoring marine pollution	**9 Hours**
Pollution Control Strategies Pollution Control strategies – Selection of optimal Outfall locations- radioactive water disposal; containment of oil at sea; oil slicks and management -chemical dispersants; water quality parameters and standards- National and International Treaties, Coastal Zone Regulation – Total Maximum Daily Load applications – Protocols in Marine Pollution – ICZM and Sustainable Development	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Massin, J. M. (1984). *Remote Sensing for the Control of Marine Pollution*. Springer.
2. Gross, M. G., Duedall, I. W., Capuzzo, J. M., & Kester, D. R. (1988). *Ocean Dumping and Marine Pollution*.
3. Laws, E. A. (2000). *Aquatic Pollution: An Introductory Text*. John Wiley and Sons, Inc.
4. Clark, R. B., Frid, C., & Attrill, M. (2005). *Marine Pollution*. Oxford Science Publications.
5. Kennish, M. J. (1996). *Practical Handbook of Estuarine and Marine Pollution*. CRC Press.

References:

1. Massin, J. M., Remote Sensing for the control of Marine Pollution, Vol. 6, Springer, 1984.
2. Gross, M. G., Ocean Dumping and Marine Pollution Duedall, I. W., J. M. Capuzzo and D. R. Kester,
3. Oceanic Processes in Marine Pollution,1988
4. Richard A Geyer., Marine Environment Pollution: Elssevier,1st edn,1981
5. Laws, E.A., "Aquatic pollution", an introductory text. John Wiley and Sons, Inc., New York, 2000.
6. R.B. Clark, C. Frid and M Atttrill, Marine Pollution, Oxford Science Publications, 5 th Edition, 2005.
7. Marine pollution Dr.P. C.Sinha , Anmol Publications Pvt. Ltd, 1998. 4. Marine Pollution: New
8. Research - Tobias N. Hofer, Nova Publishers, 2008
9. Practical Handbook of Estuarine and Marine Pollution, Michael J. Kennish, Volume 10 of CRC
10. Marine Science, CRC Press, 1996

Online Resources (Weblinks)

1. Marine Pollution | National Oceanic and Atmospheric Administration (NOAA) :

https://oceanservice.noaa.gov/facts/pollution.html
2. Marine Pollution | United Nations Environment Programme (UNEP)
https://www.unep.org/resources/report/marine-pollution
3. Marine Pollution | World Health Organization (WHO)
https://www.who.int/news-room/fact-sheets/detail/marine-pollution
4. Marine Pollution | Environmental Protection Agency (EPA)
https://www.epa.gov/ocean-dumping/marine-pollution
5. Marine Pollution | International Maritime Organization (IMO)
https://www.imo.org/en/OurWork/Environment/Pages/Marine-Pollution.aspx

Assessment (Theory course)
SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Ms.S.Rajalakshmi Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE014	Membrane separation process for Water and Wastewater treatment	L	T	P	J	C
		3	0	0	0	3
PE		SDG	3, 6			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	introduce students the fundamental principles and mechanisms of membrane separation processes, including microfiltration, ultrafiltration, nanofiltration, and reverse osmosis
2	equip with the skills to design and apply membrane technologies for water and wastewater treatment, focusing on system components, module design, and operational parameters
3	educate students on the challenges associated with membrane fouling, scaling, and cleaning, and to explore strategies for effective membrane maintenance and longevity

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand the various membrane processes, principles, separation mechanisms, and their applications in water and wastewater treatment.	U
CO 2	apply knowledge of science and engineering fundamentals to analyze the mechanisms of membrane filtration and solve related problems	Ap
CO 3	design and evaluate membrane systems for specific water and wastewater treatment applications, considering factors such as flux, pressure, and fouling	Ap
CO 4	understand and implement pretreatment and post-treatment strategies to optimize membrane performance and lifespan	U
CO 5	assess the environmental and economic impacts of membrane technologies and propose sustainable solutions for water and wastewater treatment	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3	2		2
2	3		2	2	2	
3	3	2	3	3	2	2
4		3	2		3	
5	3		3	3	2	3

Course Content

Introduction to Membrane Filtration Processes Overview of membrane technologies: microfiltration, ultrafiltration, nanofiltration, reverse osmosis - Membrane materials and structures - Principles of membrane separation and transport mechanisms	**9 Hours**
Membrane System Design and Components	**9 Hours**

Membrane module designs: plate and frame, spiral wound, hollow fiber - System components: pumps, pressure vessels, and control systems. Design considerations for membrane systems in water and wastewater treatment	
Membrane Fouling and Control Types of membrane fouling: particulate, organic, inorganic, and biological - Factors influencing fouling and scaling - Fouling control strategies: pretreatment methods, chemical cleaning, and maintenance	**9 Hours**
Applications of Membrane Technologies Case studies on the use of membranes in desalination, municipal wastewater treatment, and industrial applications - Design and operation of membrane bioreactors (MBRs) - Emerging membrane technologies and innovations	**9 Hours**
Environmental and Economic Considerations Environmental impacts of membrane processes - Cost analysis and economic feasibility of membrane systems - Sustainable practices and future trends in membrane technology.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources

Textbooks:

1. Hillis, P. (2000). *Membrane technology in water and wastewater treatment*. Royal Society of Chemistry.
2. Hidalgo, A. M., & Murcia, M. D. (2021). *Membranes for water and wastewater treatment*. MDPI.
3. Laws, E. A. (2000). *Aquatic pollution: An introductory text*. John Wiley and Sons, Inc.
4. Yoon, S.-H. (2015). *Membrane bioreactor processes*. CRC Press.
5. Baker, R. W. (2012). *Membrane technology and applications* (3rd ed.). John Wiley & Sons

References:

1. Hillis, P. (2000). *Membrane technology in water and wastewater treatment*. Royal Society of Chemistry.
2. Hidalgo, A. M., & Murcia, M. D. (2021). *Membranes for water and wastewater treatment*. MDPI.
3. Yoon, S.-H. (2015). *Membrane bioreactor processes*. CRC Press.
4. American Water Works Association (AWWA). (n.d.). *Membrane processes*. AWWA.
5. Shaban, M., Morsy, A., Mahmoud, A. S., & Abdel-Hamid, H. (2024). *Membrane separation processes: Principles, structures, materials, and future prospects*.

Online Resources (Weblinks)

1. IntechOpen. (n.d.). *Membrane separation processes: Principles, structures, materials, and future prospects*. Retrieved from http://www.intechopen.com/online-first/1192658
2. MDPI. (n.d.). *Membrane separation process in wastewater and water purification*. Retrieved from http://www.mdpi.com/2077-0375/12/3/259
3. American Water Works Association (AWWA). (n.d.). *Membrane processes*. Retrieved from http://www.awwa.org/resource/membrane-processes/
4. Royal Society of Chemistry. (n.d.). *Membrane technology in water and wastewater treatment*. Retrieved from http://books.rsc.org/books/edited-volume/470/Membrane-Technology-in-Water-and-Wastewater
5. MDPI Books. (n.d.). *Membranes for water and wastewater treatment*. Retrieved from http://www.mdpi.com/books/reprint/4354

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution		Internal Expert(s)	
			Dr. A. Geethakarthi, Department of Civil Engineering	
Recommended by BoS on				
Academic Council Approval	No:	**Date**		

24ENE015	Transport of Water and Wastewater	L	T	P	J	C
		3	0	0	0	3
PE		SDG	6, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	educate the students in detailed design concepts related to water transmission mains and its distribution system
2	plan sewer networks and storm water drain and design on computer application

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	identify the pipe losses and determine the flow measurement	U
CO 2	decide the suitable pumping mains based on their maintenance	U
CO 3	analyze various pipe distribution networks	Ap
CO 4	estimate Storm water drainage flow	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			3
2	3	2	3			3
3	3	3	3			3
4	3	2	3			3

Course Content

GENERAL HYDRAULICS AND FLOW MEASUREMENT Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying capacity – Flow measurement.	**9 Hours**
WATER TRANSMISSION Need for Transport of water and wastewater - Planning of Water System –Selection of pipe materials, concepts on water transmission mains - gravity and pumping main; Selection/Design of Pumps- characteristics – economics. Specials, Jointing, laying and maintenance	**9 Hours**
WATER DISTRIBUTION Water hammer analysis; Water distribution pipe networks: Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection - Storage reservoirs.	**9 Hours**
STORM WATER DRAINAGE	**9 Hours**

Necessity- Design of Combined and separate system Formulation of rainfall intensity duration and frequency relationships, Probable Maximum Precipitation - Estimation of storm water run-off - Rational methods	
WASTEWATER COLLECTION AND CONVEYANCE Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- Sewer appurtenances –; material, construction, inspection and maintenance of sewers; Design of sewer outfalls - mixing conditions; conveyance of corrosive wastewaters	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Davis, M. L. (2010). *Water and wastewater engineering*. McGraw-Hill Professional.
2. Steel, E. W., & McGhee, T. J. (1991). *Water supply and sewerage*. McGraw-Hill.
3. Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F. L., Tsuchihashi, R., & Stensel, H. D. (2013). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Professional.
4. Larock, B. E., Jeppson, R. W., & Watters, G. Z. (2000). *Hydraulics of pipeline systems*. CRC Press.
5. Christodoulou, S. (2017). *Urban water distribution networks*. CRC Press.

References:

1. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 2012.
2. CPHEEO, Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, GoI, New Delhi, 2012.
3. Hammer. M.J., Water and Wastewater Technology, Regents/ Prentice Hall, New Jercy, 2001.

Online Resources (Weblinks)

1. Transport of Water & Wastewater | Indian Institute of Technology Madras https://civil.iitm.ac.in/admin/coursedetailimage/CE5210%20-%20Transport%20of%20Water%20&%20waste%20water.pdf
2. Water and Wastewater Treatment Engineering | MIT Open Course Ware https://mitocw.ups.edu.ec/courses/civil-and-environmental-engineering/1-85-water-and-wastewater-treatment-engineering-spring-2006/lecture-notes/
3. Transport Processes in the Environment | MIT Open CourseWare https://ocw.mit.edu/courses/1-061-transport-processes-in-the-environment-fall-2008/pages/syllabus/
4. Water and Wastewater Engineering | University of Toronto https://www.civil.engineering.utoronto.ca/water-and-wastewater-engineering
5. Environmental Engineering: Water, Wastewater, and Subsurface | Stanford University https://cee.stanford.edu/environmental-engineering-water-wastewater-and-subsurface

Assessment (Theory course)
SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr.B.Nithyalakshmi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

PROFESSIONAL ELECTIVES

(TRACK III – ELECTIVES ON EMERGING DOMAINS)

24ENE016	Climate Change, Adaptation and Modelling	L	T	P	J	C
		3	0	0	0	3
PE		SDG	7, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	understand the science of climate change, including atmospheric processes and feedback mechanisms.
2	analyze the impacts of climate change on ecosystems, water resources, and human communities.
3	develop adaptation strategies using advanced modelling techniques and scenario analysis.
4	integrate policy frameworks and global initiatives for climate resilience and sustainable development.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	explain the underlying physical processes driving climate change	U
CO 2	assess regional and global climate models to project future climate scenarios	An
CO 3	implement several adaptation strategies for climate-sensitive sectors	Ap
CO 4	integrate climate science with policy frameworks to develop comprehensive, actionable strategies for mitigating the impacts of climate change across different sectors.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	3	2	2	1	3
2	3	2	2	2		3
3	3	3		2	3	
4	3	2	2	2	3	2

Course Content

INTRODUCTION TO EARTH'S CLIMATE SYSTEM Earth's energy balance and greenhouse effect - Climate feedback mechanisms and radiative forcing - Paleoclimate and historical climate variability -Global climate systems and atmospheric circulation.	**5 Hours**
CLIMATE CHANGE IMPACTS AND VULNERABILITY Impacts of climate change: sea level rise, extreme weather events, changes in precipitation patterns, ecosystem disruption; Ecosystem shifts and biodiversity loss; Water resource changes and extreme weather events; Human health, agriculture, and food security impacts; Socio-economic vulnerabilities and vulnerability assessment.	**9 Hours**

CLIMATE MODELLING TECHNIQUES Introduction to Climate Models - General Circulation Models (GCMs) and Regional Climate Models (RCMs) - Downscaling techniques - Data assimilation and model validation – Advanced Tools in climate modelling – Machine learning and AI in climate prediction – GIS and remote sensing for vulnerability mapping – Case Studies - Scenario analysis and uncertainty quantification.	**9 Hours**
ADAPTATION AND MITIGATION STRATEGIES Climate-resilient infrastructure -Urban heat island mitigation strategies - Disaster Risk Reduction - Water Resource Management - Coastal adaptation measures - Agricultural adaptation- Biodiversity Protection.	**9 Hours**
CLIMATE POLICY FRAMEWORKS Global climate Policy Frameworks and agreements - UNFCCC, Paris Agreement, Kyoto Protocol, Montreal Protocol, Conference of Parties (COP), IPCC and Assessment Reports; National & Regional Policies – India's National Action Plan on Climate Change (NAPCC), European Green Deal, U.S Inflation Reduction Act (IRA 2022); Local and Community-Based Actions – Urban Green Policies, Community Resilience Programs.	**9 Hours**
CLIMATE FINANCE Global Climate Finance Institutions- Green Climate Fund - Global Environment Facility (GEF); Market-based Instruments - Carbon Pricing, Emissions Trading Systems (ETS), Carbon Credits; Debt and Equity Instruments - Green bonds, Sustainability-Linked Loans, Impact Investing.	**4 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Dessler, A. E. *Introduction to Modern Climate Change*. Cambridge University Press, 2021.
2. Ruddiman, William F. *Earth's Climate: Past and Future*. 4th ed. New York: W. H. Freeman, 2020

References:

1. Schneider, S. H. et al. (2022). *Climate Change Science and Policy*. Island Press.
2. Flannery, T. (2022). *The Climate Cure*. Text Publishing.
3. NASA Climate Change Portal (https://climate.nasa.gov)
4. IPCC Official Website (https://www.ipcc.ch)
5. NOAA Climate Data Online (https://www.ncdc.noaa.gov)

Online Resources (Weblinks)

1. https://nptel.ac.in/courses/105106465
2. https://onlinecourses.nptel.ac.in/noc25_ce09/preview
3. https://ocw.mit.edu/courses/res-env-005-climate-science-risk-solutions-a-climate-primer/
4. edX: *The Science and Modeling of Climate Change (Harvard University)*

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Ms. S. Rajalakshmi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE017	Ecology and Ecosystem management	L	T	P	J	C
		3	0	0	0	3
PE		SDG	3, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	interrelate the foundational principles of ecology and their application to ecosystem management
2	understand the impact of human activities on ecosystem structure and function
3	implement strategies for the conservation and restoration of ecosystems

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand ecological concepts and their relevance to ecosystem management	U
CO2	apply ecological principles to assess human impacts on various ecosystems	Ap
CO3	analyze conservation strategies and their effectiveness in biodiversity preservation	Ap
CO4	develop comprehensive plans for ecosystem restoration incorporating scientific and community perspectives	Ap
CO5	assess the sustainability of resource management practices and propose improvements.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3	1		2
2	3		2	2	3	1
3	2	3	3		2	3
4	3	2		3	3	2
5		3	2	3	3	3

Course Content

Fundamentals of Ecology Ecosystem Structure and Function - Scope of ecology, biological levels of organization-genes to biosphere; tolerance range and limiting factors, adaptations, ecotypes and ecads. Energy Flow and Nutrient Cycling. Population ecology: Characteristics, evolutionary strategies r and k selection; population growth and regulation, Species Interactions: Biodiversity and its Significance - Competition, mutualism, parasitism, predator-prey relations, allelopathy, behavioural ecology	**9 Hours**

Human Impacts on Ecosystems Anthropogenic Changes: Diversity of life; origin of life on earth and Speciation; Human Ecology and Human Settlements. Pollution and Its Ecological Consequences: Urbanization, Agriculture, and Industrialization. Climate Change Effects on Ecosystem Health: Evolution of early life and changes in earth's atmosphere. Mendelian genetics – and Darwin Wallace theory of inheritance. Five kingdoms overview; Monera, Protists, Fungi, plant and animal kingdoms. Case Studies on Human-Ecosystem Interactions	**9 Hours**
Conservation Biology Biome and aquatic systems- distribution, characteristics, climate and biota. Conservation of different Ecosystems: forests, grasslands, and arid lands, lakes and wetlands and coral reefs. Natural and anthropogenic disturbances, Invasive species: ecology, impacts and control. Principles of Conservation and Biodiversity Preservation - Habitat Fragmentation and Wildlife Corridors - Endangered Species Management - Policy Frameworks and International Conservation Efforts	**8 Hours**
Ecosystem Restoration Restoration Ecology Theories and Practices - Techniques for Rehabilitating Degraded Landscapes - Monitoring and Evaluating Restoration Success - Community Involvement in Restoration Projects – case studies	**10 Hours**
Sustainable Resource Management Sustainable Forestry, Fisheries, and Agriculture - Ecosystem Services Valuation - Adaptive Management Strategies - Integrating Traditional Ecological Knowledge	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources:

Textbooks:

1. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Brooks/Cole.
2. Begon, M., Townsend, C. R., & Harper, J. L. (2021). *Ecology: From Individuals to Ecosystems* (5th ed.). Wiley-Blackwell.
3. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2012). *Principles of Conservation Biology* (3rd ed.). Sinauer Associates.
4. Chapin III, F. S., Matson, P. A., & Vitousek, P. M. (2012). *Principles of Terrestrial Ecosystem Ecology* (2nd ed.). Springer.
5. Van Andel, J., & Aronson, J. (2012). *Restoration Ecology: The New Frontier* (2nd ed.). Wiley-Blackwell.
6. Molles, M. C., & Sher, A. (2018). *Ecology: Concepts and Applications* (8th ed.). McGraw-Hill Education.

Reference books & Weblinks:

1. Society for Ecological Restoration (SER): https://www.ser.org
2. The International Union for Conservation of Nature (IUCN): https://www.iucn.org
3. Millennium Ecosystem Assessment Reports: https://www.millenniumassessment.org
4. The Ecological Society of America (ESA): https://www.esa.org
5. United Nations Environment Programme (UNEP): https://www.unep.org

Online Resources:

1. OpenStax: Environmental Science: https://openstax.org
2. Coursera - Ecosystem Services: A Method for Sustainable Development: https://www.coursera.org
3. MIT Open Course Ware – Ecology I: The Earth System: https://ocw.mit.edu
4. National Geographic – Ecosystem Conservation Resources: https://www.nationalgeographic.org
5. Khan Academy – Ecology and Ecosystem Management: https://www.khanacademy.org

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval		**Date**	

24ENE018	Energy and Environmental Engineering	L	T	P	J	C
		3	0	0	0	3
PE		SDG	3, 7, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	make the learners learn various energy sources, conversion technologies, and their environmental implications
2	explore the interrelationship between energy systems and environmental impact
3	equip students with the knowledge and skills necessary to develop sustainable energy solutions
4	provides rudiments of the principles of energy management, energy planning, energy audits, and energy economics

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand Energy concepts and assess the energy usage	U
CO 2	identify and assess the technological advancements in energy systems and their roles in sustainable energy management and environmental protection	Ap
CO 3	implementation of energy conservation and sustainable management practices	Ap
CO 4	conduct Energy audit for analysing energy efficiency in developmental projects	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1			2		3	3
2	3	2	2	2	3	3
3	3	2	2		3	3
4	3	2	2	2	3	2

Course Content

INTRODUCTION ON ENERGY SCENARIO Energy concepts and definitions - Earth's energy balance- Global and Indian scenario on Energy Demand and Supply Trends - Energy classification- Overview of conventional energy resources - fossil fuels, nuclear energy – Production and usage - Depletion of non-renewable energy sources of energy – Key factors in their exploitation, - Impact of use of energy on ecology - Carbon footprint and Scope of Emission and their Concepts– Energy and sustainability	**9 Hours**
EMERGING ENERGY RESOURCES AND ENERGY STORAGE TECHNOLOGIES	**10 Hours**

Sustainable energy resources, Renewable energy sources (Solar, Wind, Hydropower, Biomass, Geothermal, Tidal, Wave) - cogeneration systems - Bioenergy program in India and biogas energy, Environmental benefits and impacts. Energy storage systems - pumped hydro energy storage, compressed air storage, energy storage by flywheel, electrical battery storage, superconducting magnetic energy storage, thermal sensible energy storage, latent heat energy storage, and chemical reaction storage - Case studies	
ENERGY CONSERVATION AND SUSTAINABLE DEVELOPMENT Energy and environment - Importance of energy conservation - Role of energy in climate change - energy security - environmental issues - sustainable development - climate change - energy security for sustainable communities - Sustainable Development concepts and stakeholders – Socio-economic aspects of energy systems – Case studies	**8 Hours**
ENERGY MANAGEMENT National and International energy policies - Regulatory frameworks and guidelines - Energy Conservation Act and its features - Planning for energy management, Principles of Energy Management, Implementation of Energy Conservation and Continuing - National Mission on Energy – Case studies	**9 Hours**
ENERGY ANALYSIS AND AUDIT Energy Audit – Categories of Energy Audit, Types of Energy Audit, Measuring and Detection Instruments for Energy Survey, Scope of Energy Audit Certification - Energy audit reporting format - case study on industrial energy audit and energy conservation opportunities - Building and site energy audits, energy efficiency analysis – Case studies	**9 Hours**

Theory	Tutorial	Practical	Project	Total
Hours: 45	**Hours: 0**	**Hours: 0**	**Hours: 0**	**Hours: 45**

Learning Resources

Textbooks:

1. Energy Engineering and Management, By Chakrabarti, Amlan (2018), PHI Learning Pvt. Ltd.“Principles of Energy Conversion", By Culp A.W., (2000) Tata McGraw Hill.
2. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition, Wiley, 2022.
3. M. H. Fulekar, Bhawana Pathak, R K Kale, “Environment and Sustainable Development” , Springer, 2016.
4. “Renewable Energy", By Sorenson, B., (2004) Academic Press.
5. Energy Management Principles Smith, C.B(1981), Pergamon Press

References:

1. Energy - Efficient Buildings in India (2002) Ministry of Non-Conventional Energy Sources
2. Energy Conservation Building Code (2007) Bureau of Energy Efficiency, New Delhi.
3. Handbook on Energy Audits and Management (2000) -Tata Energy Research Institute (TERI)
4. Energy Cogeneration Handbook for Central Plant Design by George Polimeros

Online Resources (Weblinks)

1. https://nptel.ac.in/domains/discipline/103?course=103_3

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. B. Nithyalakshmi, Dr. A. Geethakarthi, Department of Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE019	Environmental Risks: Hazard, Assessment and Management	L	T	P	J	C
		3	0	0	0	3
PE		SDG	3, 13			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:	
The purpose of taking this course is to:	
1	identify and classify environmental risks and hazards using real-world case studies.
2	acquire knowledge on the qualitative and quantitative risk assessment methods for environmental risk analysis
3	develop sustainable risk management strategies considering socio-economic and regulatory factors

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	classify and interpret the different environmental hazards based on their characteristics and impacts	U
CO2	apply qualitative and quantitative methods to assess environmental risks using real-world data	Ap
CO3	apply vulnerability and sensitivity assessments to identify high-risk communities or ecosystems	Ap
CO4	analyze the effectiveness of different environmental risk management strategies in real-world case studies	An
CO5	apply risk management strategies to all case cases of hazards	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3	2	3			2
2	3	3	2	2	2	
3	2	3			2	3
4		2	3	3		2
5	3	3	2	2	3	2

Course Content

Introduction to Environmental Risk and Hazards Definitions and scope of environmental risks and hazards-Types of environmental hazards: natural vs. anthropogenic- Historical perspective and case studies (e.g., Chernobyl, Bhopal). Environmental Hazard Classification Physical hazards: earthquakes, floods, heatwaves, etc. Chemical and toxic hazards: air, water, and soil pollution biological hazards: invasive species, diseases, and pandemics Technological and industrial hazards	**8 Hours**

Risk Assessment Frameworks Concept of risk: probability and impact-Qualitative vs. quantitative risk assessment-Risk assessment methodologies: fault tree analysis, event tree analysis, Hazard and operability study (HAZOP)-Overview of risk matrices and risk scoring systems Environmental Risk Analysis - Techniques analysis and dose-response relationships Sensitivity analysis and uncertainty assessment- Environmental modeling for risk prediction (e.g., dispersion models for air pollution)-Software tools for risk analysis	**9 Hours**
Vulnerability and Sensitivity in Risk Assessment Factors influencing vulnerability: socio-economic, geographical, and demographic- The role of resilience in communities and ecosystems Climate change adaptation and environmental resilience- Regulatory Frameworks and Policies for Risk Management Overview of environmental regulations: international, national, and local levels Risk management standards (ISO 31000, Eco-Management and Audit Scheme (EMAS), OHSAS 18001)-Risk communication and public participation in environmental decision-making	**8 Hours**
Environmental Risk Management Strategies Risk avoidance, reduction, and transfer strategies -Cost-benefit analysis in environmental risk management- Integrated Risk Management (IRM) and sustainable development principles preparedness and response (ERP) plans Communication and Decision-making perception: psychological, cultural, and social factors-Risk communication techniques and best practices-Stakeholder engagement in risk management-Ethical considerations in risk decision-making	**10 Hours**
Case Studies Chemical Spill Management - Natural Hazard Management - Environmental Risks in Urban and Industrial Areas - Climate Change and Emerging Risks - Social and Economic Impacts of Environmental Risk10	**10 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources:

Textbooks:

1. Smith, K., & Petley, D. N. (2009). *Environmental hazards: Assessing risk and reducing disaster* (6th ed.). Routledge.
2. Calow, P. P. (Ed.). (2009). *Handbook of environmental risk assessment and management.* Wiley-Blackwell.
3. Whipple, D. M. (2012). *Environmental risk assessment and management.* Springer.
4. Ricci, P. F. (2006). *Environmental and health risk assessment and management: Principles and practices.* Springer Science & Business Media.
5. Pritchard, P. (2000). *Environmental risk management.* Earthscan Publications Ltd.

Reference books & Weblinks:

1. United Nations Environment Programme Finance Initiative (UNEP FI). (n.d.). *Environmental & social risk analysis (ESRA) online course.* Retrieved from https://www.unepfi.org/learning/risk-training/
2. University of Phoenix. (n.d.). *Environmental risk assessment course.* Retrieved from https://www.phoenix.edu/courses/env420.html
3. Bentham Science. (2023). *Environmental risk assessment and management.* Retrieved from https://benthambooks.com/book/9789815179392/

Online Resources:

1. Harvard T.H. Chan School of Public Health. (2023). *Environmental health risk: Analysis and applications.*
2. The Swamp School. (2023). *Ecological risk assessment training.* Retrieved from https://swampschool.org/course/ecological-risk-assessment-training/
3. Integrated Online and Onsite Training on Environmental Impact Assessment – Centre for

Science and Environment (CSE): https://www.cseindia.org/integrated-online-and-onsite-training-on-environmental-impact-assessment-12126 4. Framework for India Climate Risk Management – National Institute of Disaster Management (NIDM): https://nidm.gov.in/PDF/pubs/GIZ_NIDM_Climate%20RiskManagementFramework.pdf

Assessment (Theory course)
SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
			Dr. G.L.Sathyamoorthy, Civil Engineering
Recommended by BoS on			
Academic Council Approval	No:	**Date**	

24ENE020	Sustainable Built Environment	L	T	P	J	C
		3	0	0	0	3
PE		SDG	9, 11			

Pre-requisite courses	-	Data Book / Code book (If any)	-

Course Objectives:

The purpose of taking this course is to:

1	bring in the importance of limited availability of resources in the world and why the future of building and development will change for the future
2	understand the true impacts that the built environment will have on our communities and to endure understanding about sustainability and its measurement in monetary, social and environmental terms and the ways to implement sustainability in the environment.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand the role of engineers in sustainability science and in sustainable development	U
CO 2	identify and assess challenges and opportunities of different water resources, utility and treatment of water to meet sustainability	U
CO 3	Analyze the basic linkages between economy and environment, and perform a Cost-Benefit Analysis for an engineering solution	Ap
CO 4	understand issues associated with the design and operation of sustainable solid-waste systems with a focus on recycling, composting, and circular economy	U
CO 5	evaluate engineering decisions against the guiding principles for sustainability and measure their sustainability level	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)					
	1	2	3	4	5	6
	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Advanced scientific knowledge through appropriate tools and research methods	Design and apply technological advancements for complex Engineering	Sustainable Solutions with Emphasis on Safety and Environmental factors
1	3		3	2	2	3
2	3	3	3	2	2	3
3	3		3	2	2	3
4	3	2	3		2	3
5	3	3	3	2	2	3

Course Content

Environmental Impact on Buildings and Sustainable development Environmental impacts on building: Shortage of building materials - Noise, vibration, dust, and traffic disruptions - Food wastes - Water pollution - Disruption of natural scenery - Disappearing green spaces in urban areas; Environmental impact of economic development; Building and the environment	9 Hours

Introduction to sustainability and SDGs- Sustainable Engineering: Concepts, Principles, and Frameworks	
Attributes of environmental sustainability Pollution prevention measures in manufacturing - Waste reduction measures in manufacturing - Recycled content - Embodied energy reduction - Use of natural materials - Reduction of construction waste - Local materials - Energy efficiency - Water efficiency - Use of non-toxic materials - Renewable energy systems - Durability – Reuse – recycling – biodegradability	9 Hours
Technological innovation and sustainable built environments Electronic technology in buildings - Functional shift of built environments - Human interaction- Office automation - Telecommunications - Building systems - Building decentralization - Design intelligence - Team design approach - Bio-climatic built environments	9 Hours
Sustainable Water and Solid Waste Management Water resources, demands, distribution and use -Water quality & wastewater treatment - The Water-Energy-Food Nexus Solid-waste sources, characterization, collection and storage - Design a future without waste	9 Hours
Sustainability Assessment and Environmental Economics Sustainability Assessment - Life Cycle Assessment (LCA) - Environmental economics & Cost-Benefit Analysis	9 Hours

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45

Learning Resources

References:

1. Jong-Jin Kim, "The Sustainable Built Environment" (Vol 1), UNESCO – Encyclopaedia of Life support systems, ISBN: 978-1-84826-060-3 (eBook)
2. Jong-Jin Kim, "The Sustainable Built Environment" (Vol 2), UNESCO – Encyclopaedia of Life support systems, ISBN: 978-1-84826-061-0 (eBook)
3. Mihelcic, James R. and Julie B. Zimmerman (2014) Environmental Engineering: Fundamentals, Sustainability, Design (Links to an external site.)
4. Nelson, V. (2011) Introduction to renewable energy (Links to an external site.). CRC Press, Taylor & Francis Group, Florida.

Online Resources (Weblinks)

Assessment (Theory course)

SA I and SA II, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. B. Nithyalakshmi, Dr. A. Geethakarthi, Department of Civil Engineering

Recommended by BoS on			
Academic Council Approval		**Date**	