SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)
Vidya Nagar, Palissery, Karukutty, Ernakulam - 683576, Kerala, India.
www.scmsgroup.org/sset

SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

VIDYA NAGAR, PALISSERY, KARUKUTTY - 683576

DEPARTMENT OF CIVIL ENGINEERING

2026 Scheme

Syllabus

Semester 1

M.Tech. in Environmental Engineering Branch Code – CEEE

SEMESTER 1

Sl.	Slot	Course Code	Type	Cat.	Course Title	Cr.	Hour Structure				Total Hrs.	Marks Distribution		Total Marks
							L	T	P	SL		CIA	SEE	
1	A	261TCECC01	CC	PC	Probability and Statistics	3	45	0	0	45	90	40	60	100
2	B	261TCEEE02	PC	PC	Environmental Chemistry and Microbiology	4	45	15	0	60	120	40	60	100
3	C	261TCEEE03	PC	PC	Physicochemical Wastewater Treatment	4	45	15	0	60	120	40	60	100
4	D	261ECEEE1X	PE	PE	Program Elective 1	3	45	0	0	45	90	40	60	100
5	E	261ECEEE2X	PE	PE	Program Elective 2	3	45	0	0	45	90	40	60	100
6	F	261TCECC06	CC	SEC	Research Methodology and IPR	2	30	0	0	30	60	40	60	100
7	G	261LCEEE07	PCL	PCL	Environmental Monitoring Lab 1	2	0	0	45	15	60	100	..	100
TOTAL						21	255	30	45	300	630			

Course Code	261TCECC1	**Course Name**	Probability and Statistics
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	CC	**Course Category**	PC
Prerequisites	Nil		

Preamble

The objective of this course is to expose the students to the fundamental concepts of probability and statistics. The course aims to equip the students to find solutions for many real-world civil engineering problems and to understand basic data analysis tools by applying the principles of statistics.

Course Objectives

1. To introduce students to the fundamental concepts of probability theory and random variables.
2. To familiarize students with statistical techniques such as hypothesis testing, tests of significance, chi-square tests, and the basic concepts of least squares methods.

Course outcomes (CO)

CO#	CO Statement	Knowledge Level
CO1	Create an awareness of the concepts of statistics and probability distributions and explain the characteristics through correlation and regression tools	K2
CO2	Apply probability theory and mathematical expectations to analyze and solve engineering & real-world problems involving uncertainty	K3
CO3	Apply probability distributions to model and solve engineering and real-world problems by selecting appropriate probability distributions.	K3
CO4	Analyze sampling distributions and apply point estimation, confidence interval estimation, and large-sample hypothesis tests for means and proportions to support statistical decision-making in engineering applications.	K4
CO5	Solve the problems on testing of hypothesis on large samples and small samples and fitting of the curves.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**

Elementary Statistics
Introduction to statistics- definition-advantages-limitations-frequency distribution tables-Arithmetic mean, median, mode for grouped and ungrouped data-variance, standard deviation, co-efficient of variation. Correlation –properties, correlation co-efficient-Regression-properties-Regression coefficient- relation between correlation co-efficient and Regression co-efficient.

Module: 2	**Contact Hours: 9**

Probability Theory
Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

Module: 3	**Contact Hours: 9**

Random variables & Distributions
Probability distribution - Binomial, Poisson approximation to the binomial distribution and normal distribution-their properties-Uniform distribution-exponential distribution.

Module: 4	**Contact Hours: 9**

Testing of Hypothesis
Estimation-parameters, statistics, sampling distribution, point estimation, Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors and power of the test. Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

Module: 5	**Contact Hours: 9**

Testing of significance & Curve fitting
Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes. Curve Fitting: Fitting of Linear, Quadratic, Exponential curves, least squares method

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
20	10	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Applications of Probability Distributions in Engineering Problems
2. Binomial, Poisson, and Normal Distributions: Comparative Analysis
3. Hypothesis Testing in Environmental and Civil Engineering Data Analysis
4. Confidence Intervals and Estimation Techniques for Engineering Data
5. Student’s t-Test and F-Test in Experimental Data Analysis

Text Books

1. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, 11th Edition, Sultan
2. Vijay K Rohatgi, Statistical Inference, Aug 2003, Dover Publications Inc. Spivak, M. (2006). *Calculus*. Cambridge University Press.
3. S.P.Gupta, Statistical Methods, 33rd Edition, Sultan Chand & Sons.

Reference Books and Extended Learning

1. Benjamin, Jack.R and Comell.C, Allin, Probability, Statistics and Decision for Civil Engineers, Mc- McGraw-Hill.
2. Ross S Introduction to Probability and Statistics for Engineers and Scientists Elsevier 6th Edition 2021.
3. Johnson RA, Miller I, Freund J. Miller and Freund’s Probability and Statistics for Engineers (9th edition) Pearson. 2018.
4. Schiller J, Srinivasan RA, Spiegal M Schaum's Outline of Probability and Statistics, raw Hill

Online repository

1. https://onlinecourses.nptel.ac.in/noc22_ce46

Course Code	261TCEEE02	**Course Name**	Environmental Chemistry & Microbiology
Teaching Hours	L:45 T:15 P:0 SL:60	**Course Credits**	4
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PC	**Course Category**	PC
Prerequisites	Nil		

Preamble

Environmental chemistry is considered important at the societal level as it is associated with environmental impact, pollutants, environmental management, and contamination reduction. It covers the basic concepts and parameters related with Environmental Engineering and related issues. Environmental Microbiology helps to define the concepts in Microbiology in relation to the environment. It helps the students to understand the basic microbiological practises to be adopted for monitoring the quality of air, water and soil.

Course Objectives

1. To Introduce physical chemistry concepts relevant to environmental processes and engineering applications.
2. To enable students to develop analytical skills for qualitative and quantitative determination of environmental parameters.
3. To enable students to highlight biomolecules, surfactants, dyes, and their degradation pathways in pollution control.
4. To enable students to explore microorganisms, their classification, and their ecological significance.
5. To train students in microbiological techniques for monitoring air, water, and soil quality.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	To understand the fundamentals of physical chemistry involved in Environmental processes	K2
CO2	To choose proper analytical tools for the qualitative and quantitative determination of various Environmental parameters	K4
CO3	To realize importance of biomolecules, surfactants, dyes, and their degradation	K3
CO4	To classify and compare the general characteristics of microorganism	K2
CO5	To understand the basic concepts and techniques in Microbiology	K3
CO6	To define the concepts in Environmental Microbiology	K2

Course Syllabus

Module: 1	**Contact Hours: 9**

Introduction-solutions-normal, molar and molal solutions - vapour pressure, Henry's law, Graham's law, Raoult's law- Law of mass action - chemical equilibrium, Le Chatelier's principle

Fundamentals of chemical kinetics, Types of reactions, Rate and order of reactions Zero order, First order, Second order Reactions-Derivation of first order kinetic equation – Distribution coefficient-Principle of solvent extraction.

Theory of ionization, pH and buffers – Henderson Hasselbalch's equation – Basic concepts from surface and colloidal chemistry –preparation, classification, Properties and their stability - Zeta potential and its determination.

Module: 2	**Contact Hours: 9**

Beer – Lambert law, Principle, instrumentation and applications of spectrophotometry -UV-visible spectroscopy, IR spectroscopy, Atomic Absorption Spectroscopy (AAS), Nephelometry and Tubidimetry

Principles of Chromatography – thin layer and paper – adsorption – partition – ion exchange – HPLC, GC-size exclusion – electro chromatography.

Potentiometric titration of Iron, Acid-base conductometric titrations.

Module: 3	**Contact Hours: 9**

Biomolecules - proteins, carbohydrates, lipids , enzymes, nucleic acids, vitamins, Surfactants – Cationic, anionic and non-ionic detergents. Environmental effects- Eutrophication and Degradation. Dyes-Chemical classification (azo, anthraquinone, Phthalocyanines)-Environmental impacts of Dyes. Radioactive pollution-sources, methods of monitoring and control.

General properties of microorganisms- General properties of bacteria, fungi, algae, protozoa, rickettsia and chlamydia. Characterization & classification of microorganisms.

Module: 4	**Contact Hours: 9**

Morphology and structure of bacteria. Staining methods. Microscopy- Light and Electron Microscopy.

Culture media and growth factors for microbes. Enumeration techniques for bacteria. Growth curve of microbes.

Microbial metabolism. -. Aerobic and anaerobic growth. Physical and chemical control of microorganisms-sterilization principles and techniques. Antibiotics-mechanism of action. Microbes associated with food spoilage, food preservation methods.

Module: 5	**Contact Hours: 9**
Aeromicrobiology, outdoor and indoor, bioaerosol sampling. Air borne diseases and control. Concept of indicator organisms. -total coliforms, MPN and membrane filter techniques. water borne diseases and control. Role of microorganisms in biogeochemical cycling. Microbial leaching. Biopesticides and biofertlizers	

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
20	10	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Explain classification of Dyes
2. Explain Radioactive Pollution Sources & Remedial measures
3. Explain chromatography & Spectroscopy using suitable case study

Text Books

1. Raina.M. Maier, Ian LPepper& Charles P Gebra, Environmental Microbiology, 2nd edition ,Elsevier India Pvt ltd, New Delhi, 2008.
2. Michael. J. Pelczar, Microbiology, 5th edition Tata McGraw Hill company Ltd, New Delhi, 2010.
3. Anathanarayanan and Panikers Text book of Microbiology ,7th edition ,Orient Longman pvt ltd,2007
4. P.D.Sharma,Microbiology,4th edition Rastogi publications, Meerut, 2019.

Reference Books and Extended Learning

1. Instrumental Methods of Chemical Analysis, Dr. B. K. Sharma, 30th ed, Goel Publications, 2015
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of physical chemistry, 47th Vishal Publishing, 2016
3. Clair N. Sawyer, PeryL.McCarty, Chemistry for Environmental Engineering.
4. Donald, V. and Judith G.V., John, Biochemistry 4th ed., Wiley & Sons Asia Pvt.Ltd. (New Jersey), 2011.

Online repository

1. https://nptel.ac.in/courses/102105087

Course Code	261TCEEE03	**Course Name**	Physicochemical Wastewater Treatment
Teaching Hours	L:45 T:15 P:0 SL:60	**Course Credits**	4
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PC	**Course Category**	PC
Prerequisites	Nil		

Preamble

The course aims to impart in-depth knowledge on water and wastewater treatment techniques and enable to design suitable treatment processes based on achieving the required quality

Course Objectives

1. To provide a comprehensive understanding of the physicochemical characteristics of water and wastewater, sources of pollution, wastewater generation, collection, conveyance, and applicable water quality standards.
2. To develop the ability to analyze and design conventional physicochemical treatment processes for water and wastewater, including sedimentation, coagulation, flocculation, filtration, screening, grit removal, aeration, adsorption, and disinfection.
3. To enable the students to apply the principles and design methodologies for selecting, designing, and evaluating sustainable physicochemical treatment systems for diverse water and wastewater treatment applications.

Course Outcomes (COs)

CO #	CO Statement	Knowledge Level
CO 1	To enhance the knowledge of process kinetics involved in water/wastewater treatment	K1
CO 2	To design appropriate technologies for water treatment	K6
CO 3	To identify the possible sources of water pollutants and the methods for estimating the quantity and quality of wastewater generated	K4
CO 4	To design treatment processes accordingly to meet relevant water quality standards	K6
CO 5	To impart skills on advanced treatment technologies	K5

Course Syllabus

Module: 1	**Contact Hours: 9**
Physical and chemical quality of water, Sources of water pollution-domestic, industrial, water quality standards. Wastewater - sources, quantity, collection and conveyance. Storm water- Quantity, Factors affecting. Sewerage systems. Time of concentration, Flow rate and fluctuations of wastewater, variations in concentrations of wastewater constituents. Physical and chemical characteristics of wastewater, BOD, COD, Population equivalent, Effluent standards	

Module: 2	**Contact Hours: 9**
Sedimentation processes-types of settling, design of sedimentation tanks. Coagulation and Flocculation-Types, processes and Design. Clariflocculator. Filtration- processes, types. Hydraulics of filtration-losses in filter, Design of filters	

Module: 3	**Contact Hours: 9**
Disposal in streams, Dilution and dispersion, self-purification-factors affecting-physical, chemical, Streeter Phelps equation, oxygen sag curve. Screening-Types, Design of bar screen. Grit removal, Design of grit chamber. Flow Equalization, Design of equalization tank.	

Module: 4	**Contact Hours: 9**
Reactors, Completely mixed batch reactor, Continuous flow stirred tank reactor. Aeration- methods of aeration, Adsorption- types, adsorption isotherms, Ion exchange. Disinfection-Methods, Kinetics, Disinfection by-products	

Module: 5	**Contact Hours: 9**
Wastewater treatment by membrane based technologies- Removal of micro pollutants, membrane filtration- Ultra, Nano, Micro filtration. Membrane fouling. Desalination, Reverse osmosis, Electro dialysis. Advanced oxidation- Fenton process, catalytic treatment, Electrochemical treatment. Case studies on wastewater treatment in various processes, chemical and allied industries	

Continuous Internal Assessment (CIA)

Micro project/Course based project	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
10	20	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Prepare a report on the effluent discharge standards for industrial wastewater as prescribed by CPCB. Discuss the significance of key parameters (pH, BOD, COD, TSS, oil and grease, heavy metals, etc.) and explain how physicochemical treatment processes help industries achieve these standards.
2. Evaluate different disinfection techniques used in wastewater treatment and justify the selection of a suitable method for municipal and industrial wastewater based on efficiency, cost, and environmental considerations.
3. Prepare a case study on the physicochemical wastewater treatment practices adopted in a chemical or allied industry. Critically evaluate the treatment process with respect to pollutant removal efficiency, operational challenges, and sustainability.

Text Books

1. Metcalf & Eddy, Inc. (1991). Wastewater engineering: Treatment, disposal, and reuse. Tata McGraw-Hill Publishing Company.
2. Hammer, M. J., & Hammer, M. J., Jr. (2007). Water and wastewater technology (6th ed.). Prentice Hall of India Pvt. Ltd.
3. Weber, W. J. (1990). Physico-chemical processes for water quality control. John Wiley & Sons.
4. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental engineering. McGraw-Hill.

Reference Books and Extended Learning

1. Fair, G.M., Geyer J.C and Okun, (1969) “Water and Wastewater Engineering” Vol II, John Wiley Publications.
2. Weber W.J Physico-chemical processes for water quality control, John Willy and sons ,Newyork, 1990.
3. John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous, MWH's Water Treatment: Principles and Design, Third Edition: Principles and Design, Third Edition
4. AWWA, (1971), “Water Quality and Treatment “McGraw Hill.

Online repository

1. https://nptel.ac.in/courses/103107212

Course Code	261TCECC06	**Course Name**	Research Methodology and IPR
Teaching Hours	L:30 T:0 P:0 SL:30	**Course Credits**	2
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	CC	**Course Category**	SEC
Prerequisites	Nil		

Preamble

This course introduces the strategies and methods related to scientific research. The students are also trained in the oral presentation with visual aids and writing technical thesis/reports/research papers. The salient aspects of publication and patenting along with the crucial role of ethics in research is discussed.

Course Objectives

1. To enable students to understand the principles of research methodology, literature review, and problem identification in engineering research.
2. To enable students to develop skills in research design, methodology selection, data analysis, and problem-solving approaches.
3. To enable students to acquire effective technical communication skills through presentations, report writing, and documentation of research outcomes.
4. To enable students to understand the process of scholarly publication, intellectual property rights, and innovation through research and patenting.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Approach research projects with enthusiasm and creativity.	K2
CO2	Conduct literature survey and define research problem	K3
CO3	Adopt suitable methodologies for solution of the problem	K3
CO4	Deliver well-structured technical presentations and write technical reports.	K3
CO5	Publish/Patent research outcome.	K3

Course Syllabus

Module: 1	Contact Hours: 6

Introduction

Meaning and significance of research, Skills, habits and attitudes for research, Types of research, Characteristics of good research, Research process. Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming. Thinking skills: Levels and styles of thinking, commonsense and scientific thinking, examples, logical thinking, division into sub-problems, verbalization and awareness of scale. Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity

Module: 2	Contact Hours: 6

Literature survey and Problem definition

Information gathering – reading, searching and documentation, types of literature. Integration of research literature and identification of research gaps. Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem. Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples. Analytical and analogical reasoning, examples, Creative problem solving using Triz, Prescriptions for developing creativity and problem solving.

Module: 3	Contact Hours: 6

Experimental and modelling skills

Scientific method, role of hypothesis in experiment, units and dimensions, dependent and independent variables, control in experiment, precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors. Design of experiments, experimental logic, documentation. Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills. Continuum/meso/micro scale approaches for numerical simulation, Two case studies illustrating experimental and modelling skills.

Module: 4	Contact Hours: 6

Effective communication - oral and written

Examples illustrating the importance of effective communication, stages and dimensions of a communication process. Oral communication –verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc. Guidelines for preparation of good presentation slides. Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX. Common errors in typing and documentation.

Module: 5	**Contact Hours:6**

Publication and Patents

Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper. Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics. Introduction to IPR, Concepts of IPR, Types of IPR. Common rules of IPR practices, Types and Features of IPR Agreement, Trademark. Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures

Continuous Internal Assessment (CIA)

Group Discussion/Literature surveys of suitable topics	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Research ethics and plagiarism prevention
2. Systematic literature review techniques
3. Reference management using Mendeley and Zotero
4. Research problem identification and hypothesis formulation
5. Experimental design and statistical analysis for research
6. Technical paper writing using the IMRAD format
7. Patent search and patent drafting fundamentals
8. AI tools for literature review and research assistance
9. Publishing in indexed journals (Scopus and Web of Science)
10. Research proposal writing and funding opportunities

Text Books

1. E. M. Phillips and D. S. Pugh, "How to get a PhD - a handbook for PhD students and their supervisors", Viva books Pvt Ltd.
2. G. L. Squires, "Practical physics", Cambridge University Press
3. Antony Wilson, Jane Gregory, Steve Miller, Shirley Earl, Handbook of Science Communication, Overseas Press India Pvt Ltd, New Delhi, 1st edition 2005
4. C. R. Kothari, Research Methodology, New Age International, 2004

Reference Books and Extended Learning

1. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
2. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
3. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
4. William Strunk Jr., Elements of Style, Fingerprint Publishing, 2020

Online repository

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr24_ed08
2. https://nptel.ac.in/courses/121106007

Course Code	261LCEEE07	**Course Name**	Environmental Monitoring Laboratory –I
Teaching Hours	L:0 T:0 P:45 SL:15	**Course Credits**	2
Continuous Internal Evaluation Marks	100	**Semester End Exam Marks**	Nil
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PCL	**Course Category**	PCL
Prerequisites	Nil		

Preamble

The objective of this course is to enable students to familiarise themselves with various analytical techniques in Environmental Engineering. The course is also designed to make students familiar with different softwares related to Environmental Engineering.

Course Objectives

1. Understand analytical techniques in Environmental Chemistry for the analysis of water and wastewater samples.
2. Gain knowledge of microbiological practices essential for laboratory work and environmental monitoring.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	To understand the various analytical techniques in Environmental Chemistry for the analysis of water and waste water samples	K2
CO2	To understand the various Microbiological practises in the laboratory	K4
CO3	To carry out biological water quality analysis of a given sample	K3
CO4	To apply software in Environmental Engineering practices	K2

Course Syllabus

Sl. No:	List of Experiments Any 10 experiments are Mandatory)
1	Analysis of water quality parameters like pH, Conductivity, Turbidity, Alkalinity and Total solids in a given sample.
2	Analysis of Residual Chlorine and Iron in a given water sample
3	Analysis of Chlorides and Sulphate in a given water sample
4	Analysis of Nitrate and Phosphate in a given water sample
5	Analysis of BOD and COD in a given water sample

6	Analysis of oil and grease in a given water sample
7	Determination of Optimum coagulant dosage for the given turbid water sample
8	Study of instruments and equipment in a Microbiology Lab
9	Culture media preparation and Pure culture techniques in Microbiology
10	Preparation of Gram-stained smear of bacteria
11	Isolation of microorganisms from soil ,water & air
12	Determination of total bacterial population by standard plate count technique.
13	Analysis of coliforms and *E coli* by MPN and Membrane filtration technique
14	Introduction to Environmental Engineering software

Continuous Internal Evaluation (CIE)

CIE	Total
100	100

The laboratory courses will have only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

Text Books

1. APHA (2017) Standard methods for the examination of water and waste water, 23rd edn. American Public Health Association, Washington, DC
2. Mamta Tomar (1999),Quality Assessment of Water and wastewater ,Lewis Publishers

Reference Books and Extended Learning

1. R. C. Dubey and D. K. Maheshwari (2002), Practical Microbiology, S.Chand publishers
2. F.W. Fifield and P.J. Haives Blackie (2000) Environmental Analytical Chemistry, Academic & Professional Glasgow.
3. N.Gray, M Calvin and S C Bhatia (2019) Instrumental Methods of Analysis, CBS Publishers and distributors, New Delhi.A. Skoog and Donald M. West, Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning ,2013

Online repository

1. https://nptel.ac.in/courses/103106162

PROGRAM ELECTIVE 1

Course Code	261ECEEE11	**Course Name**	Environmental Impact Assessment and Management
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

The goal of this course is to expose the students to the fundamental concepts and purpose of Environmental Impact Assessment and the need for environmental management. After this course, students will be able to assess the impact of a particular developmental project and be able prepare an EIA report.

Course Objectives

1. To introduce the fundamental concepts, principles, procedures, and legal framework of Environmental Impact Assessment (EIA) and Environmental Management.
2. To enable the students to develop the ability to identify, assess, and evaluate the environmental impacts of developmental projects on various environmental resources using appropriate assessment methodologies.
3. To equip students with the skills to prepare and interpret Environmental Impact Statements (EIS) and Environmental Management Plans (EMP) through analysis of real-world case studies and developmental projects.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Understand the basic concepts and purposes of Environment Impact Assessment	K2
CO2	Assess the impact of developmental activities on the environment	K3
CO3	Evaluate the impact of various environmental resources	K3
CO4	Explain the principles and objectives of Environment Management Plan	K2
CO5	Generate EIS on the basis of various case studies related to developmental projects	K4

Course Syllabus

Module: 1	**Contact Hours: 9**
Environment Impact Assessment (EIA) Introduction to EIA- EIA Guidelines and notification of Govt. of India-Procedure for reviewing Environmental Impact Analysis and Statement-Definition, aim, principles, concepts and purposes of EIA Components or participants of EIA Types of EIA- Rapid EIA- Comprehensive EIA- Strategic Environment Assessment (SEA) Types of Impact-Primary & Secondary-Short Term & long term Reversible and Non-Reversible-Positive and Negative impacts	

Module: 2	**Contact Hours: 9**
Process and Methods of EIA Screening, Scoping, Environmental Baseline data collection. Factors causing environmental effects in development projects Identification of Impacts-Prediction of Impacts, Consideration of alternatives Evaluation and assessment of impact-Assessment of effects on - Human beings, Flora, fauna and geology Mitigation Measures-Public Consultation and Participation Environment Impact Statement Preparation Methods of EIA – (Leopold Metric)- Networks Method- Overlays Method- Index Method-Simulation Mode- Cost Benefit Analysis	

Module: 3	**Contact Hours: 9**
Various Impact Analysis Air quality impact analysis - Air pollutants-sources -Atmospheric interaction- Environmental impact assessment methodology Water quality impact analysis – water quality criteria and standards –Environmental setting- modelling - water quality impacts by projects like highways, power plants, mining, agriculture and irrigation, forest management Vegetation and wildlife impact analysis – assessment methodologies Energy impact analysis- Energy impact considerations, organization and methodology. Socio economic impact analysis- Types of socio-economic Impacts ISC – Outline the basic steps in performing a socioeconomic impact assessment.	

Module: 4	**Contact Hours: 9**
Environmental Management Plans (EMP) Objectives of EMP, Components of EMP- Environmental Monitoring- Principles & types of Monitoring-Environmental Auditing-Guidelines for Auditing-Objectives and benefit of Auditing-Steps in Auditing. Types of Auditing Environmental Management Systems (EMS)- Benefits of EMS. International Standard Organization and ISO 14001.	

Module: 5	**Contact Hours:9**
EIA case studies Case studies of EIA-Nuclear Power plants -Hydroelectric Projects Thermal Power Plants-Mining projects-Transportation projects industries-development projects Preparation of checklist for various stages of projects (examples only)	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. EIA Notification 2006 and Environmental Clearance Process in India
2. Environmental Impact Assessment of Hydroelectric Projects
3. Environmental Impact Assessment of Highway and Transportation Projects
4. Preparation of Environmental Management Plans (EMP) for Infrastructure Projects
5. Environmental Monitoring Techniques for Air and Water Quality
6. Environmental Auditing and ISO 14001 Environmental Management Systems
7. Application of GIS and Remote Sensing in Environmental Impact Assessment
8. Socio-economic Impact Assessment of Development Projects
9. Comparative Study of EIA Methodologies (Leopold Matrix, Network, Overlay, and Simulation Methods)
10. Public Consultation and Stakeholder Participation in Environmental Impact Assessment

Text Books

1. Larry W. Canter, Environmental Impact Analysis. McGraw Book Co ,New York
2. John G. Rau and David C. Wooten, Environmental Impact Analysis Handbook, McGraw Hill Book Company.

Reference Books and Extended Learning

1. Agarwal S. K., Environmental Management, A P H Publishing Company , New Delhi
2. Bhatia A. L., Sustainable Environment Impact Assessment, Avishkar Publishers. Jaipur
3. Peter Wathern , Environment Impact Assessment: Theory and Practices, Unwin Hyman, Boston
4. Shrivastava A K, Environment Impact Aseesment, A P H Publishing Corporation, New Delhi

Online repository

1. https://nptel.ac.in/courses/124107160

Course Code	261ECEEE12	**Course Name**	Sustainable Technologies and Cleaner Production
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

The aim of this course is to educate students about 'Cleaner Production Techniques' and its application, leading to pollution minimization in a sustainable manner. Students will gain knowledge in the domains of environmental, economic and technological aspects of Cleaner Production Methods.

Course Objectives

1. To introduce the concepts, principles, and significance of Pollution Prevention and Cleaner Production in achieving sustainable industrial development.
2. To enable the students to develop the ability to analyze and implement Cleaner Production methodologies, waste minimization strategies, and pollution prevention techniques in industrial processes.
3. To familiarize students with sustainable technologies, Life Cycle Assessment (LCA), Environmental Management Systems (EMS), and environmental auditing for improved environmental performance.
4. To equip students with the skills to evaluate and apply Pollution Prevention and Cleaner Production practices through industrial case studies and feasibility analysis.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	To examine the significance of Pollution Prevention and Cleaner Production concepts in engineering	K3
CO2	To analyse the step-by-step procedure for Cleaner Production Methodology	K3
CO3	To analyse and apply suitable sustainable technologies in various engineering applications	K3
CO4	To analyse Life Cycle Assessment and Environmental Management Systems	K3
CO5	To apply the concept of pollution prevention and cleaner production techniques in industrial production based on case studies	K3

Course Syllabus

Module: 1	Contact Hours: 9

Concept of Pollution Prevention and Cleaner Production:

Importance - Historical Evolution – Benefits - Promotion - Barriers – Role of Industry, Government and Institutions - Environmental Management Hierarchy.

Source Reduction techniques – Process and Equipment Optimization, Reuse, Recover, Recycle, Raw material substitution.

Industrial Ecology – Pollution Prevention (PP) and Cleaner Production (CP) in achieving Sustainability-Prevention versus Control of Industrial Pollution.

Module: 2	Contact Hours: 9

Cleaner Production Methodology:

Theory of cleaner production – Effect, Need and Barriers for Cleaner Production

Six step methodology for Cleaner Production - Total quality management - Project development and implementation – Overview of CP Assessment steps and skills, Preparing the site, Information gathering, and Flow diagram, Material balance, PP and CP Option generation, Technical and Environmental Feasibility analysis, Total Cost analysis - PP and CP Financing

Establishing a Program - Organizing a Program- Preparing a program plan - Measuring progress – Pollution Prevention and Cleaner Production Awareness Plan - Waste Audit- Environmental Statement

Module: 3	Contact Hours: 9

Sustainable technologies:

Greenhouse gases and carbon credit- carbon sequestration. Sustainable development through trade - carbon trading – SDGs and cleaner production.

Green technologies – Green technologies for sustainable water management, ZLD processes, Green computing, Intelligent Construction Machinery.

Sustainable Energy - Energy production from biomass and wastes and energy conservation

Module: 4	Contact Hours: 9

Life Cycle Assessment and Environmental Management Systems:

Economic, Environmental, and Social Performance Indicators LCA - Steps in conducting LCA - Life Cycle Costing

Environmental certifications - Eco labelling – Energy staI rN–TERDISC Certified Carbon Neutral - The Global Organic Textile Standard – USDA Organic

Green building certification – national and international.

Good housekeeping – checklists and implementation International Environmental Standards - ISO 14001 – Eco Warranty.

Module: 5	**Contact Hours:9**
Case Studies on Cleaner Production: Cleaner production case studies - Industrial Applications of PP and CP, LCA, EMS and Environmental Audits in the following industries : Textile processing industry, Distillery, Paper mill, Dye manufacturing industry, Construction industry, Petroleum industry	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Pollution Prevention vs. Pollution Control: A Comparative Study
2. Cleaner Production Strategies for Sustainable Industrial Development
3. Process Optimization Techniques for Waste Minimization
4. Industrial Ecology and Circular Economy in Manufacturing Industries
5. Six-Step Cleaner Production Methodology: Applications and Challenges
6. Material Balance Analysis for Pollution Prevention Assessment
7. Life Cycle Assessment (LCA) in Industrial Environmental Management
8. Environmental Management Systems (EMS) and ISO 14001 Implementation
9. Waste Audit Techniques in Industrial Operations
10. Cleaner Production Practices in the Textile, Paper, and Construction Industries

Text Books

1. Misra Krishna B., “Clean Production: Environmental and Economic Perspectives”, Springer, Berlin, Latest edition ISBN -13 :978-3-642-79942-6
2. Freeman, H.M, Industrial Pollution Prevention Handbook”, McGraw Hill”, latest edition ISBN-10 : 0070221480; ISBN-13 : 978-0070221482
3. Dr. Ruth Hillary, “Environmental Management Systems and Cleaner Production”, Wiley, New York, Latest edition ISBN-10 : 9780471966623; ISBN-13 : 978-0471966623
4. Paul L. Bishop, “Pollution Prevention: Fundamentals and Practice”, McGraw-Hill International, latest edition. ISBN-10 : 0073661473; ISBN-13 : 978-0073661476

Reference Books and Extended Learning

1. Environmental Life- Cycle Assessment- Marry Ann Curran, McGraw Hill, 1996. ISBN-10: 007015063X; ISBN-13: 978-0070150638
2. World Bank Group, "Pollution Prevention and Abatement Handbook-Towards Cleaner Production", World Bank and UNE, Washington D.C., latest edition. ISBN-10: 082133638X; ISBN-13: 978-0821336380
3. James G. Mann and V.A. Liu, "Industrial Water Reuse and Wastewater Minimization", McGraw Hill, 1999. ISBN-10: 0071348557; ISBN-13 : 978-0071348553

Online repository

1. http://www.gcpcgujarat.org.in/
2. http://www.unido.org/ncpc.html

Course Code	261ECEEE13	**Course Name**	GIS and Remote Sensing for Environmental Applications
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

The goal of this course is to provide students with a strong foundation in the principles of satellite remote sensing and the applications of Geographic Information Systems (GIS) in environmental engineering. Upon successful completion of the course, students will be able to process and analyze satellite imagery, interpret geospatial data using GIS tools, and apply these techniques to address a wide range of environmental engineering challenges.

Course Objectives

To impart fundamental knowledge of satellite remote sensing, GIS, and GPS, including their principles, characteristics, and significance in environmental engineering.

1. To develop students' skills in processing, analyzing, and interpreting geospatial data using remote sensing techniques and GIS software (QGIS/ArcGIS).
2. To enable students to apply geospatial technologies and spatial analysis techniques to investigate, analyze, and solve environmental engineering problems, supporting informed decision-making.

Course Outcomes (COs)

CO#	CO Statement	Knowledge Level
CO1	Explain the fundamental concepts, physical principles, and characteristics of remote sensing, and evaluate the capabilities of various satellite sensors.	K2
CO2	Process and analyze remote sensing datasets using digital image processing techniques.	K3
CO3	Analyze the applications of Geographic Information Systems (GIS), Global Positioning System (GPS), and Remote Sensing in environmental science and engineering.	K4
CO4	Apply spatial data analysis techniques using GIS and remote sensing tools to interpret geospatial data and propose appropriate solutions to environmental engineering problems.	K3
CO5	Demonstrate practical proficiency in using QGIS/ArcGIS for geospatial data management, spatial analysis, map preparation, and visualization to support environmental engineering applications.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Fundamentals of Remote Sensing **Principles of Remote Sensing -** Physics of remote sensing, Electromagnetic radiation (EMR) and its interaction with Earth surface features, Atmospheric windows and atmospheric effects, Spectral signatures of natural and man-made features **Remote Sensing Systems and Image Processing -** Types of remote sensing: Active and Passive systems, Remote sensing platforms and satellite orbits, Sensor characteristics: Spatial, Spectral, Temporal, and Radiometric resolutions, Image Interpretation - Elements of digital image interpretation, Principles of digital image processing, image correction techniques- atmospheric, geometric and radiometric, Image data encoding methods: BIL, BIP, and BSQ, False Color Composite (FCC)	

Module: 2	**Contact Hours: 9**
Applications of Remote Sensing Land Surface and Terrain Analysis - Supervised and Unsupervised classification, Digital Elevation Models (DEM) and Digital Terrain Models (DTM), Analysis of land surface biophysical properties, Land Surface Temperature (LST), Land Use/La**nd Cover (LULC) classification** Natural Resource Assessment - Soil type mapping and soil moisture monitoring, Vegetation indices and their applications, Agricultural and ecosystem monitoring using remote sensing Environmental and Water Resource Applications **-** Aerosol Optical Depth (AOD) and air quality monitoring, Remote sensing of water quality, Flood mapping and disaster management	

Module: 3	**Contact Hours: 9**
Introduction to Geographic Information System (GIS) **Fundamentals of GIS** - Introduction to GIS, History and development of GIS, components of GIS, Coordinate reference systems, datum and projections, map scales **Spatial Data Acquisition and Management -** Georeferencing, Spatial data concepts, data sources in GIS, data input methods, file formats for GIS standard GIS packages. **GIS Data models and Database Management -** Type of data, Spatial and attribute data, Data models-vector and raster, Spatial data structure- Vector data structure and raster data structure, Database management systems (DBMS), Relational database management systems (RDBMS	

Module: 4	**Contact Hours: 9**
Data Analysis in GIS **Spatial Analysis Techniques -** Spatial data analysis, single layer operations- spatial and attribute query, buffer analysis, point pattern analysis, network analysis, surface analysis, Interpolation. **Overlay Analysis and Geoprocessing -** Multi-layer operations-topological overlays, point in polygon, line in polygon, polygon in polygon, logical operators-AND, OR, NOT, XOR, vector overlay operations -Clip, erase, split, union, identity and intersect; raster calculators **Global navigation satellite systems-** types, Global positioning system- components and principle, satellite ranging- calculating position, GPS errors and biases, Differential GPS (DGPS)	

Module: 5	**Contact Hours: 9**
Application of GIS **Familiarising a GIS tool** – Georeferencing, Creation of Shapefile, Data model analysis, Creation of DEM, Overlay analysis **GIS in Land and Urban Resource Management -** Application of GIS in Urban planning, agriculture, landuse/land cover changes**,** GIS in disaster management, natural resources management**.** **GIS in Natural Resource and Disaster Management -** Application of GIS in mapping and navigation, site suitability analysis for infra projects, environmental science, network analysis.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Development of shapefile in QGIS
2. Georeferencing in QGIS
3. Vector data and Raster data analysis in QGIS

Textbooks

1. Lillesand T.M. and Kiefer R.W., Remote sensing and Image Interpretation, Second Edition, John Wiley and Sons, 1987.
2. AnjiReddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001
3. Chang, K (2005). Introduction to Geographic Information Systems, Tata McGraw Hills Edition, NewDelhi.

Reference Books and Extended Learning

1. Manual of Remote Sensing, American Society of Photogrammetry and Remote Sensing, 1993.
2. Paul Curran P.J., Principles of Remote Sensing , ELBS, 1983.
3. Sabins F.F. Jr., Remote Sensing Principles and Interpretation, W.II. Freeman and Company, 1978.
4. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992.
5. Burrough P.A., Principles of GIS for Land Resources Assessment, Oxford Publication, 1980.

Online repository

1. https://nptel.ac.in/courses/105103193

Course Code	261ECEEE14	**Course Name**	Mitigation and Adaptation Strategies in Climate Change
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

The course aims to enrich the understanding of causes, impacts, adaptive measures, and mitigation of climate change. The course also covers the global and regional level policies to control the factors influencing climate change.

Course Objectives

1. To enable students to understand the scientific principles governing the global climate system and the causes of climate change.
2. To enable students to analyze climate change impacts on natural and built environments and evaluate global and national mitigation initiatives.
3. To enable students to apply climate change adaptation and mitigation strategies for enhancing environmental sustainability and resilience.
4. To enable students to develop analytical and problem-solving skills for addressing climate change challenges through appropriate assessment methodologies and engineering interventions.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Describe the physical principles of global climate system	K2
CO2	Identify the global initiatives to address climate change challenges and mitigation measures.	K2
CO3	Analyse the impacts of climate change on various environmental components.	K3
CO4	Demonstrate various adaptation techniques related to climate change issues.	K3
CO5	Adopt suitable methodologies to mitigate the damages due to climate change	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Introduction to climate change. Atmospheric structure and composition. Causes of climate change. Solar radiation and global energy budget. Climate forcing, Climate Feedback, Albedo Number Environmental indicators and instrumental records Human Footprints on global warming. Greenhouse gases emission scenario Ethics and Environmental Policy: International Initiatives: Climate Policies - UNFCCC, Paris Agreement, Montreal Protocol, SDG. National Action Plan on climate change. State Action Plan on Climate Change. Social Movements and Global Civil Society.	

Module: 2	**Contact Hours: 9**
Loss and Damage Associated with Climate Change Loss and Damage - on agriculture, Livestock, biodiversity, human health, Coasts and Estuaries Climate change vulnerability assessment. Economics of climate change.	

Module: 3	**Contact Hours: 9**
Climate Change Adaptation Needs and Practices Geo-informatics in Climate Change Studies- Basic concepts Improving preparedness – seasonal forecast and early warning. Responding to uncertainties (strategies to adapt an uncertain climate change)- Risk & recovery insurance, Food security. Adapting cities for climate change: Infrastructure and planning, role of green infrastructure, changes in National Building codes and standards, ecosystem-based adaptation.	

Module: 4	**Contact Hours: 9**
Climate change Mitigation Characteristics of mitigation in regional and national context; Long term and short-term mitigation options. Energy Conservation and Fuel Efficiency, Renewable energy sources: Solar power, wave power, wind power, hydro power, Geothermal energy, nuclear energy and biofuels.	

Module: 5	**Contact Hours:9**
Non-energy approaches to Climate Change Mitigation Recovery – sequestration - disposal of greenhouse gases. Carbon Conversion Technologies: CO2 Capture, Geological Storage, chemical absorption, membrane capture and gasification technology. Mitigation of Flood related issues. Case studies on climate disasters and mitigation	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Carbon Capture, Utilization, and Storage (CCUS) Technologies
2. Geological Carbon Sequestration and CO_2 Storage Methods
3. Flood Risk Mitigation and Climate-Resilient Flood Management
4. Climate Disaster Case Studies: Kerala Floods, Cyclones, and Heatwaves
5. Renewable Energy Technologies for Climate Change Mitigation

Text Books

1. Mark Masli, Climate Change: A Very Short Introduction, Oxford University Press, 2014.
2. Jepma C.J. and Munisinghe M, Climate Change Policy-Facts, Issues and Analysis, Cambridge University Press,1998.
3. Dessler A (2016) Introduction to Modern Climate Change. 2nd Edition. Cambridge University Press. ISBN: 978-521-17315-5

Reference Books and Extended Learning

1. Navroz K. Dubash(2011), Handbook of Climate Change and India, Development, Politics and Governance Routledge.
2. Burroughs WJ (2007) Climate Change: A multidisciplinary approach. 2nd Edition. Cambridge University Press. Pp.390. ISBN: 978-0-521-69033-1
3. Barry RG and Chorley RJ. (2010). Atmosphere, weather and climate. 8th Edition. Routledge, New York. pp.421
4. Mitsutsune Yamaguchi (2012) Climate Change Mitigation Balanced Approach to Climate Change, Springer London Heidelberg New York ISBN 978-1-4471-4227-0

Online repository

1. https://nptel.ac.in/courses/105106465
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge06

PROGRAM ELECTIVE 2

Course Code	261ECEEE21	**Course Name**	Environmental Health and Safety
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

Environment Health and Safety, give practical suggestions for protecting the environment along with maintaining health and safety. It highlights the need for sanitation and safety in public and private spaces and equips the students to practise general hygiene and adopt various measures for the control of various communicable diseases. Hence this course is very beneficial as for practising Environmental engineers and students.

Course Objectives

1. To enable students to understand the principles of communicable disease transmission, prevention, and public health management.
2. To enable students to acquire knowledge of occupational health hazards, emerging diseases, and workplace health protection measures.
3. To enable students to develop skills in public health surveys, environmental sampling, sanitation assessment, and data collection procedures.
4. To enable students to apply occupational health practices and risk assessment techniques for improving public health and environmental safety.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	To understand the mode of transmission and control measures of various communicable diseases.	K2
CO2	To outline occupational and emerging diseases.	K2
CO3	To formulate the procedures adopted for Survey and sample collection.	K3
CO4	To discuss the Sanitation practices adopted in public spaces.	K2
CO5	To practice Occupational health and evaluate risk assessment.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Communicable diseases Infection and disease -Normal flora, pathogenicity, types and mode of transmission of diseases Bacterial diseases: pathogenicity, mode of transmission and control - Diarrhea, Typhoid, Cholera, TB , Plague Viral diseases: pathogenicity, mode of transmission and control - Chicken pox, Measles, Mumps, Rabies, AIDS, polio, Dengue Protozoal diseases: pathogenicity, mode of transmission and control - Malaria, Kala Azar, Gambia fever	

Module: 2	**Contact Hours: 9**
Occupational illness & Emerging diseases Asbestos, Silica, Lead, Nickel, Arsenic and Mercury toxicity Pathogenicity, mode of transmission and control- COVID19, Ebola virus disease Nipah viral diseases, Tick fever, Zika viral disease, Monkey pox Antimicrobial resistance and risk factors	

Module: 3	**Contact Hours: 9**
Survey on food borne &water borne diseases Investigation of water and food borne diseases outbreaks-general, sanitary survey, medical survey, samples, epidemiologic reports Environmental sample collection and processing-processing of soil and water samples for bacterial, viral and protozoal analysis. Risks from Pathogens in Biosolids Water and Food borne illness-disease transmission and control Air borne pathogens and toxins , bioaerosol control	

Module: 4	**Contact Hours: 9**
Sanitation Swimming Pool sanitation, Restaurant sanitation, Slaughter house sanitation, Milk plant sanitation and Sanitation of Hospitals. Sanitation Related Diseases and Control Measure Vector borne and zoonotic diseases-transmission and control.	

Module: 5	**Contact Hours:9**
Occupational health & Risk assessment Accident Prevention and Elimination Plans, Fire Protection Techniques, Safety equipment Radiation health -Biological effects of radiation, Bioterrorism, Emerging contaminants-pharmaceuticals and personal care products, antibiotics, chemical household products, micro plastics	

Elements of risk assessment -hazard identification, exposure assessment, dose response assessment, risk characterization, microbial risk assessment.

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Occupational Health Hazards and Workplace Safety Management
2. Fire Protection Systems and Emergency Preparedness in Public Buildings
3. Radiation Exposure, Biological Effects, and Radiation Safety
4. Emerging Contaminants in Water and Their Public Health Impacts
5. Microbial Risk Assessment in Water and Food Safety
6. Sanitation Management in Hospitals and Healthcare Facilities
7. Vector-Borne and Zoonotic Diseases: Prevention and Control Strategies
8. Investigation and Epidemiology of Water-Borne Disease Outbreaks
9. Environmental Sampling Techniques for Pathogen Detection in Soil and Water
10. Bioaerosols, Airborne Pathogens, and Indoor Environmental Health Protection

Text Books

1. Raina.M.Maier, Ian L Pepper& Charles P Gebra, Environmental Microbiology, 2 nd edition Elsevier India Pvt ltd, New Delhi, 2008.
2. P.D.Sharma,Microbiology,4th edition Rastogi publications, Meerut, 2019.
3. R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi ,2006.

Reference Books and Extended Learning

1. Environmental Engineering; Joseph A Salvato ,Nelson N Nemero, Franklin .J Agardy 5 th edition Wiley interscience publication,2003.
2. Slote.L, Handbook of Occupational Safety and Health, 2 nd edition, John Willey and Sons, NewYork, 1999
3. Ernest Hodgson, A Text book of Modern Toxicology , 4 edition , John Willey and Sons, NewYork, 2010

Online repository

1. https://www.who.int/health-topics/environmental-health

Course Code	261ECEEE22	**Course Name**	Instrumental and Analytical Techniques in Environmental Engineering
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

Instrumental and analytical techniques in Environmental Engineering includes studies and methods to separate, identify, and quantify parameters related with Environmental Engineering. This helps the students to create a thorough knowledge about research related activities in Environmental Engineering. This paper also covers the concepts of Chemistry related issues of Environmental Engineering. Hence this paper is very essential for Environmental Engineers and researchers.

Course Objectives

1. To enable students to understand and apply biochemical and analytical techniques for environmental sample analysis.
2. To enable students to develop skills in laboratory procedures, environmental monitoring, and analysis of soil, water, and air quality parameters.
3. To enable students to acquire knowledge of nanotechnology-based analytical methods and modern environmental characterization techniques.
4. To enable students to apply novel environmental research methodologies and interpret analytical results for sustainable environmental engineering applications.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	To apply various Biochemical techniques in Environmental Engineering labs.	K3
CO2	To analyse various biochemical parameters related with soil, water and air.	K3
CO3	To formulate the procedures adopted for analysis of various test samples.	K3
CO4	To discuss the various nanotechnology techniques for Environmental analysis.	K2
CO5	To practice suitable novel methods for Environmental research applications.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Introduction to Environmental Chemical analysis Soils: Sampling and storage, Pre-treatment, Extraction of organic contaminants, extraction of available ions-Dissolution technique for the determination of total metal concentration in soil- Determination of pH, Cation Exchange Capacity (CEC), total and available metal ions. Air: Air sampling techniques and analytical methods for monitoring SO_2, NO_2, CO, H_2S and Suspended Particulate Matter (SPM). Water and Wastewater: Sampling - grab and composite sampling, preservation, storage, pre-treatment	

Module: 2	**Contact Hours: 9**
Principles and applications of Analytical Techniques Principles and applications (any three for each) of selected analytical methods used in environmental chemical analysis: Titrimetry, Gravimetry, Colorimetry. Principle, instrumentation and applications of Amperometric titrations (sulphate, Magnesium, lead) Conductometry- Measurement of conductance, TDS, conductometric titration-acid-base, precipitation (chloride estimation). Principle and applications of Nephelometry and Turbidimetry, Turbidimetric titration (Ba2+ Vs Sulphate) Potentiometry – acid base titrations	

Module: 3	**Contact Hours: 9**
Spectrophotometry and X-ray Techniques Principle, Instrumentation and applications of UV Visible spectrophotometry, IR Spectrophotometry. Principle, instrumentation and applications of Atomic Absorption Spectroscopy (AAS), Atomic Emission Spectrophotometry-Flame photometry, Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Basic principles and applications of X-Ray Fluorescence spectroscopy (XRF), X-Ray Diffraction studies and X-Ray Photoelectron spectroscopy (XPS)	

Module: 4	**Contact Hours: 9**
Advanced separation techniques General principle of chromatography, Definitions-Elution, retention time, Retention volume, Normal and Reverse phase chromatography, Retention factor. Theory, instrumentation and applications Gas Chromatography, High-Pressure Liquid Chromatography (HPLC), Gel permeation Chromatography (GPC), and Ion-exchange chromatography. Electrophoresis and its applications, capillary electrophoresis. Gel electrophoresis: SDS- PAGE Isoelectric focusing, 2-D gel electrophoresis and their applications in Environmental Engineering	

Module: 5	**Contact Hours:9**
Nanotechnology techniques used in Environmental Engineering Nanometerials-Definition, classification, characteristics. Nanocomposites. Air purification using nanomaterials. Wastewater purification with nanobubbles, nanosorbents, nano filtration systems for heavy metals. Nano biosensors -glucose biosensors, alcohol biosensors. Nano particles for degradation of organic pollutants. Metal/Metal oxide nanoparticles for water treatment, Anti-microbial activity of silver nanoparticles-mechanism, Zerovalent Iron nanoparticles-synthesis, heavy metal removal Silica nanoparticles synthesis, functionalisation and applications, Carbon nano tubes, Dendrimers, Quantum dots and nano sponges- definition, synthesis and environmental applications	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Biosensors for environmental monitoring
2. Nanomaterials for water and wastewater treatment
3. Polymerase Chain Reaction (PCR) techniques in environmental microbiology
4. Nanotechnology applications in air pollution monitoring
5. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) analysis methods
6. Advanced environmental analytical instruments (GC-MS, HPLC, ICP-MS)
7. Microbial bioremediation of contaminated soil and groundwater
8. Environmental metabolomics and biomarker analysis
9. AI and machine learning applications in environmental laboratory data analysis

Text Books

1. S.K. Banerjee –Environmental Chemistry, 2004.
2. Chatwal and Anand Instrumental methods of analysis, Dhanpat Rai, 2001
3. Clair N. Sawyer, PeryL. Mc Carty, Chemistry for Environmental Engineering, McGraw Hill, 2002
4. Maheshwar Sharon, Madhuri Sharon (2012). “Bionanotechnology”. CRC PressINC, ISBN: 1439852146, 9781439852149.

Reference Books and Extended Learning

1. Holtzhauer, M. (2006) Basic Methods for the Biochemical Lab. 1st English edition. Springer.
2. Cantor, C. R. and Schimmel, P. R. (1980) Biophysical Chemistry. Part III. 1st edition. W. H. Freeman & Co.

Online repository

1. https://nptel.ac.in/courses/103108100

Course Code	261ECEEE23	**Course Name**	Environmental System Modeling
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

This course introduces the principles and applications of environmental systems modelling for analysing and predicting the behavior of pollutants in air, water, groundwater, and noise environments. It emphasizes the development and application of mathematical models as decision-support tools for effective environmental assessment and management.

Course Objectives

1. To introduce students to the fundamentals of environmental systems modelling, model classifications, and the principles involved in model development and evaluation.
2. To develop students' understanding of air pollution modelling techniques and mathematical models used for estimating the transport and dispersion of atmospheric pollutants.
3. To familiarize students with the principles of water quality modelling and the application of mass balance and transport equations for assessing pollutant behaviour in rivers and lakes.
4. To provide students with knowledge of groundwater flow and contaminant transport processes using mathematical models for groundwater quality assessment.
5. To equip students with the principles of environmental noise modelling and the application of noise prediction and mapping techniques for environmental planning and management.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	Explain the fundamental concepts, classifications, and development principles of environmental system models.	K2
CO2	Apply mathematical models to analyze the transport and dispersion of pollutants in atmospheric environments.	K3
CO3	Evaluate the fate and transport of pollutants in surface water systems using water quality modelling approaches.	K3

CO4	Analyze groundwater contaminant transport and apply appropriate modelling techniques for groundwater quality assessment.	K3
CO5	Apply environmental noise modelling and mapping techniques for environmental planning and decision-making.	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Role of models in environmental pollution studies- Environmental management and modelling -modelling principles Types of models-classification of mathematical models-deterministic, stochastic, continuous, discreet, static, dynamic, linear and non-linear Model building framework-model calibration, validation, verification and sensitivity analysis-model scales, error and uncertainty	

Module: 2	**Contact Hours: 9**
Air pollution modelling: Transport and dispersion of air pollutants-Atmospheric stability-lapse rates and dispersion-plume behaviour-maximum mixing depth Estimating concentrations from point sources – dispersion modelling- Gaussian Plume Model – determination of dispersion parameters. Receptor models-Chemical Mass Balance (CMB) and Positive Matrix Factorization (PMF) models Box models- introduction to indoor air quality modelling-CFD models	

Module: 3	**Contact Hours: 9**
Water quality modelling: River hydrology and flow– low flow analysis – Discharge of pollutants into rivers-Behaviour of conservative and non-conservative substances-transport-advection, diffusion and dispersion - Dissolved oxygen in rivers, Streeter-Phelps equation, modification to Streeter-Phelps Equation Modelling lake water quality-mass balance for well mixed lakes-steady state solution-transfer function and residence time - dynamic state analysis (simple cases only), Introduction to MIKE software	

Module: 4	**Contact Hours: 9**
Groundwater modelling: use of ground water models ground water flow modelling -Darcy's law-ground water flow equations for homogenous, heterogenous, isotropic and anisotropic conditions Mass transport of solutes-transport and transformation of contaminants in groundwater-the transformation processes–the non-reactive processes, the reactive processes-simulation of transport and transformation processes, formulation of the governing equations, initial and boundary conditions-solutions for simple cases. Seawater intrusion- Ghyben–Herzberg Principle – basic concepts and modelling, introduction to FEFLOW	

Module: 5	**Contact Hours:9**
Environmental noise - noise generation mechanisms- need for noise modelling Modelling inputs-sound propagation factors- Equivalent Continuous Sound Pressure Level (Leq) Noise mapping methodology-modelling traffic noise	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Application of Artificial Intelligence and Machine Learning in Environmental Modelling.
2. Climate Change Modelling and Greenhouse Gas Assessment
3. CFD Applications in Environmental Engineering
4. Groundwater Contamination Risk Assessment
5. Environmental Decision Support Systems (EDSS)

Text Books

1. ARAL, Mustafa Aral. Environmental modeling and health risk analysis *(*ACTS/RISK). Springer Science & Business Media, 2010.
2. R.W. Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994
3. Steven C. Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997.
4. Todd David Keith, Ground water Hydrology, Fourth edition, John Wiley and Sons, New York, 2004.

Reference Books and Extended Learning

1. Nirmalkhandan N. (2001) Modeling Tools for Environmental Engineers and Scientists, CRC Press, Boca Raton, Florida.
2. Schnelle K.B. and Dey P.R. (1999) Atmospheric Dispersion Modelling Compliance Guide, McGraw-Hill.
3. Thomann R.V. and Mueller J.A. (1987) Principles of Surface Water Quality Modelling and Control, Harper & Row, New York.
4. Murphy, Enda, and Eoin A. King. Environmental noise pollution: Noise mapping, public health, and policy. Elsevier, 2022.

Online repository

1. https://ocw.mit.edu?utm_source=chatgpt.comhttps://nptel.ac.in/courses/127106004
2. https://www.epa.gov/air-quality-models?utm_source=chatgpt.com
3. https://www.dhigroup.com/academy?utm_source=chatgpt.com

Course Code	261ECEEE24	**Course Name**	Ecological Engineering
Teaching Hours	L:45 T:0 P:0 SL:45	**Course Credits**	3
Continuous Internal Evaluation Marks	40	**Semester End Exam Marks**	60
Exam Hours	2½ Hours	**Total Marks**	100
Course Type	PE	**Course Category**	PE
Prerequisites	Nil		

Preamble

This course aims to expose the students to the fundamental concepts of ecology, biodiversity and the need for its conservation. After this course, students will be able to assess the value of biodiversity and able to analyse the impact of human activities on the ecosystem and suggest mitigation measures to restore the ecosystem.

Course Objectives

1. To enable students to understand the structure, functions, and ecological processes of ecosystems and communities.
2. To enable students to evaluate biodiversity, ecosystem interactions, and the factors influencing biodiversity conservation.
3. To enable students to analyse biogeochemical cycles, ecological indicators, and the environmental impacts of pollutants on ecosystems.
4. To enable students to apply biodiversity assessment methods and ecological analysis techniques for environmental monitoring and conservation planning.

Course Outcomes (COs)

CO	CO Statement	Knowledge Level
CO1	To point out the basic concept and functions of an ecosystem	K2
CO2	To evaluate various elements of biodiversity and able to identify the impacts on biodiversity	K3
CO3	To judge community organization and various biogeochemical cycles involved in a community	K3
CO4	To summarise the effects of pollutants on the ecosystem	K3
CO5	To analyse various biodiversity indices	K3

Course Syllabus

Module: 1	**Contact Hours: 9**
Fundamentals of Ecology: Components of Ecosystem-Structure-function and size of the ecosystem Scope and application of ecotechnology- Relevance of echo technology to human civilization. Natural eco-systems ecological Food chains, Food webs and Ecological pyramids- Structure and functions of an ecosystem - Producers, consumers and decomposers Productivity and ecological efficiencies. Ecosystem degradation - Resource utilisation- - important types of ecosystems in India (e.g., Wetland ecosystem including estuaries, tidal marshlands, swamps, lakes etc.) Aquatic ecosystems (ponds, lakes, streams, rivers, estuaries, oceans)	

Module: 2	**Contact Hours: 9**
Biodiversity: Types and elements of biodiversity- Composition and levels of biodiversity- Biodiversity Hotspots - Concepts of diversity. Diversity in ecosystems and habitat classification. Biodiversity depletion-causes and consequences- Human impacts on biodiversity. Biodiversity and its conservation ecosystems - speciation and extinctions.	

Module: 3	**Contact Hours: 9**
Community organization and Energy flow Nutrient cycles-Energy Flow- Biogeochemical Cycles-Trophic Relations-Food chain. The energy cycle - Integration of cycles in nature- Ecological Succession-Kinds of Succession (Hydrarch and Xerarch) Community Organization: Ecological Niche-Interactions between species: Competition-Predation-Mutualism-CommensalismParasitism-Allelopathy	

Module: 4	**Contact Hours: 9**
Effects of pollutants on ecosystem General effects of air, water and land pollutants, biological interactions with pollutants. Ecosystem responses to deoxygenating, nutrient enrichment, pesticides, hydrocarbons etc. Ecotechnology for waste treatment-wetlands and ponds. Restoration, Reclamation, and Regeneration of Degraded or Destroyed Ecosystems.	

Module: 5	**Contact Hours:9**
Applied Ecology Estimating Abundance: -Mark and Recapture Method -Quadrat and Line Transects-Distance and Removal Methods-Trapping and Collection Techniques-Census technique for Avifauna and Wildlife. Species Diversity measures: -Species Richness-Species Heterogenicity (Simpson's Indices, Shannon-Wiener Indices)- Vegetational Profile assessments- Taxonomy and Biosystematics. Eco-informatics-concepts and principles.	

Continuous Internal Assessment (CIA)

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred)	CTA	Test paper, 1 no (Test paper shall include minimum 80% of the syllabus)	Total
15	15	10	40

Suggested Assignments for Course Teacher's Assessment (CTA) Through Self-Learning Component:

1. Biodiversity hotspots of India and the Western Ghats.
2. Invasive alien species and ecosystem degradation.
3. Wetland ecosystem conservation and restoration.
4. Carbon cycle and climate change interactions.
5. Ecological footprint and sustainability assessment.
6. Biodiversity indices (Shannon, Simpson, and Margalef indices).

Text Books

1. Krebs C J (1989), Ecological methodology, Harper Collins Pub. New York
2. Kurian Joseph & R. Nagendran, Essential Environmental studies, Pearson Education, New Delhi,2004.
3. Michael P (1990), Ecological methods for laboratory and Field Investigations, Tata McGraw Hill Publishing Company Limited, New Delhi.
4. Mitsch, J.W & Jorgensen, S.E, Ecological Engineering-An Introduction to Ecotechnology, John Wiley & Sons, New York 1989.

Reference Books and Extended Learning

1. Etnier, C. and Guterstam, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers, NewYork, 1997.
2. Eugene P Odeum, Garry W Barrett, Fundamentals of Ecology, Brooks Cole, 1997.
3. Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice, Lewis Publishers, New York, 2003.

Online repository

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc19 pp23
2. https://nptel.ac.in/courses/127106004