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

OUR MISSION:
Department of Civil Engineering, Anna University shall contribute to technological and social development by
1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the M.E. Environmental Management Programme will

PEO1  Gain knowledge and skills in environmental management which will enable them to have a career and professional accomplishment in the public or private sector organizations

PEO2  Become consultants and entrepreneurs on sustainable development issues related to clean water and sanitation, solid waste management, climate change, environmental policies, environmental impact assessment, environmental Management systems and pollution prevention.

PEO3  Become and develop processes and technologies to meet desired environmental protection needs of society and formulate solutions that are technically sound, economically feasible, and socially acceptable

PEO4  Enter into research and development studies of Environmental Management and Environmental Policies leading to research degrees and innovative solutions

PEO5  Lead the implementation of environmental policies and practices and raise awareness at all levels of an organization, about emerging environmental issues with due consideration of health, safety, and socio cultural factors and advocate policies, systems, processes and equipment for sustainable development.

PROGRAMME OUTCOMES (POs):

PO  Programme Outcomes
1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
   Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
3. Demonstrate in-depth knowledge of environmental management, with an ability to develop, implement, monitor and maintain environmental strategies, policies, programmes and systems that promote sustainable development.
4. Evaluate environmental performance including compliance with environmental legislation across the organization, and coordinate all aspects of pollution control, waste management, environmental health and conservation.
5. Identify, formulate, analyze, and develop management systems and formulate solutions that are technically sound, economically feasible, and socially acceptable
PEO/PO Mapping:

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**TOTAL CREDITS** | **23**
## RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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

UNIT II  ENVIRONMENTAL STATISTICS
Statistical descriptors of environmental data – numerical and graphical; uncertainty – accuracy, precision and bias estimation of environmental data; variability and errors in environmental data. concept of random variable and its relevance. Probability concepts; probability distribution functions and their applications-discrete and continuous distributions. Probability distribution applications.-

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

UNIT IV  ENVIRONMENTAL DATA ANALYTICAL TOOLS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:
By the end of this course, students will be able to:
CO1  Statistically analyse and present the environmental data
CO2  demonstrate the applications of statistical techniques to problems drawn from industry, management and other engineering fields
CO3  Explain major statistical analysis and modeling techniques for scientific understanding of environmental problems
CO4  Select appropriate statistical analysis methods depending on particular environmental problem and type of data
CO5  Apply major statistical analysis and modeling techniques to particular dataset, and interpret the results from such applications.

REFERENCES:
EM3101 DESIGN OF WATER AND WASTEWATER TREATMENT SYSTEMS

UNIT I PRINCIPLES OF TREATMENT

UNIT II DESIGN OF WATER TREATMENT PLANTS

UNIT III DESIGN OF CONVENTIONAL WASTEWATER TREATMENT PLANTS

UNIT IV DESIGN OF ADVANCED WASTEWATER TREATMENT PLANTS

UNIT V RESIDUAL MANAGEMENT OPERATION AND MAINTENANCE ASPECTS

TOTAL : 60 PERIODS
CO3 Design of conventional wastewater treatment units
CO4 understand in detail about the design of advanced wastewater treatment units
CO5 design the different elements of sludge treatment systems and understand the importance
O&M issues pertaining to WTP and STP

REFERENCES:

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* 1-low, 2-medium, 3-high

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EM3102 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

UNIT I ENVIRONMENTAL AQUATIC CHEMISTRY
Stoichiometry and mass balance-chemical equilibria, acid base, solubility product(Ksp), chemical kinetics, fate of chemicals and typical pollutants in aquatic environment, - characteristics of water pollution, volatilization, coagulation, partitioning, hydrolysis, photochemical transformation- Degradation of pesticides and surfactants - Metals, complex formation, oxidation and reduction.

UNIT II ATMOSPHERIC AND ENVIRONMENTAL SOIL CHEMISTRY

UNIT III CLASSIFICATION AND CHARACTERISTICS OF MICROORGANISMS
Classification and distribution of microorganisms – aerobic and anaerobic cultures, synchronous and asynchronous culture, batch, fed batch and continuous culture. measurement of growth factors affecting growth. extremophiles: Microbial interactions - chemolithotrophic organisms and biogeochemical cycles – Nutrition and metabolism in microorganisms, growth phases, carbohydrate,
protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb’s cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics - importance (NO3 respiration, SO4 respiration, Halorespiration).

UNIT IV  MICROORGANISMS AS INDICATORS OF POLLUTANTS

Water borne pathogens and their effects, transmission of pathogens, - total coliforms, E-coli, streptococcus, clostridium, concentration and detection of virus, factors influencing toxicity. effects – acute, chronic, test organisms – toxicity testing, microbial toxilology and degradation of xenobiotics - bioconcentration – bioaccumulation, biomagnification, bioasssay, biomonitoring, bioleaching. - emerging Contaminants biodrgradation – factors affecting biodegradation.

UNIT V  APPLICATIONS OF MICROORGANISMS FOR CLEAN ENVIRONMENT


LIST OF EXPERIMENTS

A: Environmental Chemistry
1. Estimation of hardness in Water sample by volumetric titration
2. Estimation of Na/K in soil by Flame Photometer
3. Determination of sulphate
4. Determination of phosphate
5. Determination of Total Solids, Total suspended solids, Total dissolved solids
6. Determination of COD in the wastewater sample
7. Determination of BOD in the wastewater sample

B: Environmental Microbiology
1. Preparation of culture media
2. Isolation and enumeration of bacteria in soil
3. Isolation and enumeration of bacteria in water
4. Detection of algae in water
5. Identification of bacteria using Gram Staining technique
6. Bacteriological analysis of wastewater (Coliforms & Streptococcus) – MPN Technique
7. Bacteriological analysis of wastewater (Coliforms & Streptococcus) MF technique

TOTAL : 105 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1: Explain the various chemical pollutants present in aquatic environment, their sources, characteristics, and the chemical reactions involved
CO2: Demonstrate knowledge and understanding of various soil and atmospheric chemical environment arise in nature, apply the knowledge to explain the real-world environmental chemistry. Capable of using theoretical knowledge to solve real-world type problems.
CO3: Gain knowledge on the distribution of various microorganisms in different ecosystems, the factors affecting the growth of the organisms, the significance of the organisms inorganic matter decomposition and environmental clean up
CO4: Select appropriate techniques to enumerate the pathogens in wastewater, exploitation of microorganisms to indicate the various pollutants in water and design experiments to remove the pollutants from wastewater using microorganisms
CO5: Apply the knowledge to design appropriate methods or experiments to treat the wastewater to remove the nutrients by utilizing the suitable microorganisms, their nutrient requirement and the metabolic pathway
REFERENCES

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* 1-low, 2-medium, 3-high

EM3103 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

UNIT I SUSTAINABILITY CONCEPT AND PRINCIPLES 9

UNIT II SUSTAINABLE DEVELOPMENT GOALS AND SOCIETY 9
Social short fall and ecological overshoot of nations - United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas -The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability -Actions to reach the 2030 Agenda for sustainable development - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth,Indigenous People, Non-Governmental Organizations and Local Authorities .
UNIT III ECOSYSTEM CONSERVATION AND RESTORATION
Conservation vs restoration - Prevention, Precaution, Preservation and Public Participation - Selection and implementation of restoration interventions - SustainableConsumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism — ClimateChange –Paris agreement -Mitigation and Adaptation - Safeguarding Marine Resources

UNIT IV SCIENCE, TECHNOLOGY AND INNOVATION FOR SUSTAINABILITY

UNIT V MONITORING AND ASSESSING PROGRESS
Sustainability in global, regional and national context – Actions to localizing SDGs - Performance indicators of sustainability and Assessment mechanism - Approaches to measuring and analyzing sustainability— limitations of GDP- Data Driven Assessment of Sustainability – carbon footprint-Ecological Footprint- Human Development Index-business charter for sustainable development - SDGs, ESG, CSR and Sustainability ESG Reporting and Corporate Sustainability- National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  
  CO1 Explain and evaluate current challenges to sustainability, including social, environmental, and economic issues.
  
  CO2 Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
  
  CO3 Develop a fair understanding of the social, economic and ecological linkage of Humanwell being, production and consumption
  
  CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
  
  CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:
5. NITI Aayog (2022), The Indian Model of SDG Localisation, and other Reports of NITI Aayog, Government of India
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EM3104  EM ENVIRONMENTAL POLICY AND LEGISLATIONS

UNIT I  INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS AND INTERNATIONAL SCENARIO

UNIT II  INDIAN CONSTITUTIONS -ENVIRONMENTAL PROTECTION
Introduction to environmental laws in India; Indian Constitution and Environmental Protection, Bhopal gas tragedy -Constitutional provisions concerning Environment Articles 14,15,(2) (b) 19 (e),21,31,32,38,39,42,47, 48-A,49,51,51-A: Indian Environmental Policy 2006 Administrative machinery for pollution control. Common Law & Criminal Law Nuisance, Negligence, Strict liability and Absolute liability, Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440) Section 133 of Cr.P.C.

UNIT III  REMEDIES FOR ENVIRONMENTAL POLLUTION

UNIT IV  MAJOR INDIAN ENVIRONMENTAL LEGISLATIONS

UNIT V  ENVIRONMENT AND DEVELOPMENT CASE LAWS
Meaning and concept of development - Its impact on environment; conflict between environment and development, Concept of Sustainable Development, Environment Impact Assessment Notifications- Public Hearing Notifications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 be familiar with the laws, policies and institutions in the field of environment in national as well in international level

CO2 acquire the skills needed for interpreting laws, policies and judicial decisions in a holistic perspective

CO3 acquire the ability to evaluate the role of law and policy in conservation and management of natural resources and prevention of pollution

CO4 Critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria

CO5 Understand and the Legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance

REFERENCES:
1. Leelakrishnan P., Environmental Law in India, Butterworths, 1998
8. Statutory Materials Bare Act/s
9. Hand Book of International Environmental Law UNEP Publication

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

UNIT I RESEARCH PROBLEM FORMULATION 9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools
UNIT III  DATA ANALYSIS, INTERPRETATION AND REPORTING  9
Sampling, sampling error, measures of central tendency and variation; test of hypothesis- concepts;
data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction,
methoodology, results and discussion, conclusion sections of a manuscript; guidelines for writing
thesis, research proposal; References – Styles and methods, Citation and listing system of
documents; plagiarism, ethical considerations in research

UNIT IV  INTELLECTUAL PROPERTY RIGHTS  9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical
indications, Copy rights, applicability of these IPRs; IPR & biodiversity; IPR development process,
role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features
of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V  PATENTS  9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps,
specifications, types of patent application; patenting process - patent filling, examination of patent,
grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents,
registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of
data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament,

EM3201  ENVIRONMENTAL ECONOMICS  L T P C
3 0 0 3
UNIT I  PRINCIPLES OF ECONOMICS  9
Environment as an Asset - Interaction between economy and environment – Economic concepts of
Wealth, Welfare, Scarcity, Growth, Sustainability, Costs, Benefits, Opportunity costs ,Social Costs-
Trade off and marginal thinking- Marginal Costs and Marginal Benefits –Positive and Normative
criteria for decision making - Equi marginal principle- Abatement costand Efficient level of pollution-
Marginal Damage Functions –Consumer Choice theory – Economic Efficiency and Markets– Supply
and Demand– Consumers’ surplus - Producers’ surplus and net social benefit -Static and dynamic
efficiency - market failures –Property Rights, Externalities, and Environmental Problem - Coase
Theorem - Public Goods and Externalities – Free rider problem – Tragedy of the commons

UNIT II  ECONOMIC VALUATION OF ENVIRONMENTAL RESOURCES  9
Types of Economic value - Environmental Benefits and Environmental Costs – Classifying economic
valuation methods– Direct and indirect methods – Surrogate markets – Stated Preference and
UNIT III  ECONOMICS OF POLLUTION PREVENTION AND CONTROL  9

UNIT IV  ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION  9

UNIT V  NATURAL RESOURCE ECONOMICS  9
Natural Resources and Environmental resources – Concept and Classification , Scarcity and its economic implications - Economics of depletable and non renewable resources – Recyclable resources – Replenishable but depletable resources – Storable renewable resources – Renewable common property Resources–Optimal Use of Exhaustible Resources-
Natural resources accounting - Economics of Forestry and fisheries exploitation –Trade and environment – Income Effects and Environmental Kuznets Curves – Race to the Bottom and Pollution Haven Hypothesis - Porter Hypothesis

COURSE OUTCOMES:
• On completion of the course, the student is expected to be able to
  CO1 explain the various terms and basic principles of environmental economics
  CO2 apply the knowledge of science and engineering fundamentals to analyse costs, benefits and value of environmental and natural resources accounting
  CO3 design of economic instruments and policies for optimal pollution, economics of exhaustible resources and renewable resources
  CO4 select appropriate economic instruments and policies for environmental management taking into account the impact of the solutions in a sustainability context
  CO5 conduct research pertinent to environmental economics and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:
1. Tom Tietenberg, Lynne Lewis, Environmental Economics: The Essentials, Taylor & Francis, 2019
2. Tom Tietenberg, Lynne Lewis, Natural Resource Economics: The Essentials, Taylor & Francis, 2019
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EM3251 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT L T P C 3 0 0 3

UNIT I INTRODUCTION 9

UNIT II IMPACT IDENTIFICATION AND PREDICTION 9

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 9
Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. Factors and methodologies - individual and family level impacts. Communities in transition-rehabilitation.

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

UNIT V ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

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

Attested

DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
REFERENCES
1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India

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

UNIT I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS 9
Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, Plastic wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated solid waste management planning.

UNIT II WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING 9

UNIT III WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY 9
Door to door collection of segregated solid wastes - analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes – principles and design of transfer and transport facilities - hazardous waste transport and manifests - mechanical processing and material separation technologies – Size reduction – size separation - density separation - magnetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – E-waste kiosks - case studies on waste collection and material recovery.

UNIT IV BIOLOGICAL AND THERMAL PROCESSING OF WASTES 9
Biological and thermo chemical conversion technologies – composting – biomethanation – incineration – pyrolysis- plasma arc gasification – principles and design of biological and thermal
treatment facilities - MSW processes to energy with high-value products and specialty BY-Products - operation of facilities and environmental controls - treatment of biomedical wastes – case studies and emerging waste processing technologies.

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

COURSE OUTCOMES:
• On completion of the course, the student is expected to be able to
CO1 Explain the various functional elements of solid and hazardous waste management including the associated legal, health, safety, and cultural issues as well as responsibilities of different stakeholders
CO2 Apply the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes, assess the factors affecting variation and assess performance of waste treatment and disposal systems
CO3 Design of systems and processes to meet specified needs of waste minimization, storage, collection, transport, recycling, processing and disposal.
CO4 Select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in a sustainability context
CO5 Conduct research pertinent to solid and hazardous waste management and communicate effectively to different stakeholders as well as engage in independent lifelong learning

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

COURSE OUTCOME:
CO 1 Identify various innovative and latest advancements in the Environmental field through research studies.
CO 2 Improve their communication skills and understand the art of writing research work through analysis of a specific topic in the related field.
CO 3 Learn to make good presentation and explain a concept.

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TOTAL: 30 PERIODS

EM3311  
PRACTICAL TRAINING (4 WEEKS)  
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Syllabus Content:
• Students shall undertake training either individually or group (not exceeding four members in a group) in reputed Companies identified by Centre for Environmental Studies, dealing with Water treatment, sewage treatment, effluent treatment, Solid waste Processing Facility, Industrial Waste management cells, Environmental consultancies, Air pollution control, Environmental Impact Assessment and any other environmental management related works during the summer vacation of II semester for a specified period of four weeks.
• Students allowed to get field exposure and effectively interact with Environmental engineers and managers in the field.
• At the end of training, a detailed report on the work done should be submitted to the course coordinator.
• Students will be evaluated through a viva-voce examination by a team of internal staff members constituted by HoD.

COURSE OUTCOME:
CO 1 Understand the various organizations and to have an exposure on projects carried out and understand the real field problem and compare the theoretical knowledge with field.
CO 2 Develop knowledge in analysing and understand the professional ethics.
CO 3 Solve Environmental related problems in the field either individually or in team.

Attested

V.P. 
DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
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EM3312 PROJECT WORK I

SYLLABUS:
The student individually works on a specific topic supervised by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or filed related studies. The progress if the work will be evaluated internally through reviews by a committee constituted by HoD. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work, methodology for carrying out the work and results of preliminary works. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner, Supervisor and an Internal Examiner.

TOTAL: 180 PERIODS

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

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EM3411 PROJECT WORK II

SYLLABUS:
The student may continue the Project work I on the selected topic as per the formulated methodology or they can do different project in an industry. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner, Supervisor and an Internal Examiner.

TOTAL: 360 PERIODS
COURSE OUTCOME:
- students will be able to

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

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PROFESSIONAL ELECTIVE COURSES

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

UNIT I INTRODUCTION 9

UNIT II AIR POLLUTION MONITORING AND MODELLING 9
Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants – Modelling Techniques – Air Pollution Climatology.

UNIT III CONTROL OF PARTICULATE POLLUTANTS 9

UNIT IV CONTROL OF GASEOUS POLLUTANTS 9

UNIT V NOISE POLLUTION 9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
After completion of this course, the student is expected to be able to understand:
CO1 Various types and sources of Air Pollution and its effects
CO2 Methods of source and ambient monitoring and dispersion of pollutants and their modeling
CO3 The principles and design of control of particulate pollutants
CO4 The principles and design of control of Gaseous pollutant
CO5 Sources, effects and control of vehicular, indoor air and noise pollution

REFERENCES:
7. P.K.Behera ,S.K.Sahu,Environmental Monitoring and Analysis, Dominant publishers and Distributors, New Delhi, 2009
8. Central Pollution Control Board Guidelines for real time sampling and analysis 2013.

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EM3001 SOIL POLLUTION AND REMEDIATION TECHNOLOGIES L T P C 3 0 0 3

UNIT I GENERATION OF WASTES AND CONSEQUENCES OF SOIL POLLUTION 9
Introduction to Geo environmental engineering – Environmental cycle – Sources, production and classification of waste – Causes of soil pollution – Factors governing soil pollution interaction clay minerals - Failures of foundation due to waste movement.

UNIT II SITE SELECTION AND SAFE DISPOSAL OF WASTE 9

UNIT III TRANSPORT OF CONTAMINANTS 9

UNIT IV WASTE STABILIZATION 9
UNIT V  
REMEDIAION OF CONTAMINATED SOILS
Exsitu and Insitu remediation-Solidification, bio-remediation, incineration, soil washing, phyto remediation, soil heating, vetrification, bio-venting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the student is expected to be able to understand:
CO1 The generation of wastes and consequences of soil pollution
CO2 Site selection and safe disposal of waste
CO3 Transport of contaminants
CO4 Waste stabilization Techniques
CO5 Remediation of contaminated soils

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EM3002  ENVIRONMENTAL QUALITY MONITORING

UNIT I  
MONITORING AND CHARACRATERIZATION OF ENVIRONMENT
General approach to environmental analysis, Choice of Lab.Vs. Field analysis, Environmental monitoring-current and future status-sensors and remote, Lab. Standards, Data quality objectives, statistics in environmental monitoring, Accuracy and precision, detection limit, types of errors, Automated Data acquisition and processing-sensors and transducers, Monitoring Network and real time monitoring

UNIT II  
ENVIRONMENTAL SAMPLING
Location, planning, Types of sampling, sampling equipment’s for water, solids and air, sample storage for physical and chemical contaminants, types of sampling, representative samples, sample preparation techniques-Solvent Extraction, SPE, Head space, Purge and trap and SPME

UNIT III  
WATER ANALYSIS
Techniques for analysis of major ions-UV-visible Spectrophotometer, Flame photometer, AAS, ICP (AES and MS), Trace organic pollutants(PCB, dioxins, pesticides) GC and HPLC (Columns Detectors and Application)

UNIT IV  
ATMOSPHEREIC ANALYSIS
Ambient air and flue gas, Gaseous pollutants-Determination of time weighted average concentration(Absorption trains, solid adsorbents and differential tubes), Direct reading instruments(fluorescence, chemiluminescent, IR and Electrochemical sensors, GC-MS for trace organics, Particulate sampling methods- High volume sampler, personal sampler, PM 10 and 2.5, Blackcarbon, Metals Direct(XRF) and dissolution methods(AAS/AES)
UNIT V ANALYSIS OF SOIL AND WASTE

Problem in analysis of soil and Waste - sampling, pretreatment - extraction and clean up, New extraction techniques, Automated soxhlet and solvent extraction, microwave digestion and sonication, SCF(CO2), Analysis for trace pollutants, Analysis of leachate.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the basics of environmental monitoring
CO2: Able to select appropriate sampling protocol for chemical analysis
CO3: Understand various methods of analysis of pollutants in water
CO4: Select correct method for toxic pollutants estimation in air
CO5: Familiar with analysis of land and wastes

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EN3252 INDUSTRIAL WASTEWATER POLLUTION - PREVENTION AND CONTROL 3 0 0 3

UNIT I INTRODUCTION

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

UNIT III INDUSTRIAL WASTEWATER TREATMENT
Equalization and Neutralization – Oil Separation - Flotation - Precipitation - Aerobic and Anaerobic Biological Treatment - Treatability studies - Air Stripping – Refractory organics removal by Absorption - Nitrification and Denitrification - Phosphorous removal - Heavy metal removal - Sequencing Batch

UNIT IV  WASTEWATER REUSE AND RESIDUAL MANAGEMENT  9

UNIT V  CASE STUDIES  10

TOTAL: 45 PERIODS

COURSE OUTCOME:
• On Completion of the course, the student is expected to be able to
CO1 Explain the source and types of industrial wastewater and their environmental impacts and choose the regulatory laws pertaining to environmental protection
CO2 Identify industrial wastewater pollution and implement pollution prevention, waste minimization in industries
CO3 Develop various technologies for removal pollutants from industrial wastewater and design wastewater treatment systems for industries
CO4 Audit and analyze environmental performance of industries to internal, external client, regulatory bodies and design water reuse management techniques
CO5 Conduct research to develop effective management systems for industrial wastewater that are technically sound, economically feasible and socially acceptable

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UNIT I LIFE CYCLE THINKING AND LIFECYCLE MANAGEMENT
Introduction to Life Cycle Thinking — Industrial ecology— Life cycle management (LCM) and Stakeholder Expectations - LCM drivers and issues - materials flow analysis -Life cycle of Products and services- International organizations and networks - History and definition of LCA - analytical tools for product and service systems -Value creation along the life cycle—technical characteristics—applications—limitations.

UNIT II LCA GOAL, SCOPE AND INVENTORY

UNIT III LIFE CYCLE IMPACT ANALYSIS AND INTERPRETATION

UNIT IV DESIGN FOR ENVIRONMENT AND ECO LABELLING

UNIT V LCA SOFTWARES AND CASE STUDIES
LCA Software - LCA Software Demo: Sima Pro, GREET, BEES, CMU EIO, GABI - Advances in LCA; Hybrid LCA, Thermodynamic LCA-LCA case studies on Product Design, Product Improvement; Product Comparison and Policy development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
- Explain the various functional elements of Life Cycle Analysis and Design for Environment
- apply the knowledge of science and engineering fundamentals to characterize the environmental interactions of products and services
- design of engineering system taking into account the material flow and pollutant interactions between engineering decisions and the environment
- select appropriate LCA tools to support product/process design and decision making, taking into account the impact of the solutions in a sustainability context
- conduct research pertinent to Life Cycle Management and communicate effectively to different stakeholders in terms of eco labels as well as engage in independent life-long learning
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EM3004 ENVIRONMENTAL SOCIAL GOVERNANCE

UNIT I INTRODUCTION
9
Fundamentals and strategies of Environmental Social Governance (ESG) - ESG in international context - Sustainability and ecological transition - Effects of climate change on liabilities, rating and valuation - Standards, norms and recommendations for transparency and reporting - Energy efficiency and its importance - ESCO models and financing trends - Circular Economy and the ESG’s impact - Role of technology in the green transition- ESG in India.

UNIT II ENVIRONMENT, CLIMATE CHANGE, GREEN TRANSITION & SUSTAINABLE FINANCE
9

UNIT III SOCIAL INCLUSION AND GENDER EQUALITY
9
Social pillars - Implementation of social and gender criteria - Challenges and future trends in gender equality - Best Practices: Equality in the board of directors and top management - Creating the ESG Culture within the organization -Involvement of organizations’ employees in ESG policies - Importance of social inclusion at multiple levels.
UNIT IV  GOVERNANCE
Evolution of corporate governance frameworks - development of corporate governance - Sustainability and ESG – Governance Factors - ESG regulation and impact - Sustainability and reputational risk of the company - Company governance and risk management - The future of governance: challenges and opportunities - Implementing environment, social and governance factors into companies - Getting shareholders' commitment to the corporate strategy.

UNIT V  ESG ANALYSIS, VALUATION, AND INTEGRATION
Different approaches of integrating ESG analysis – Qualitative and quantitative approaches – Tangible and intangible material ESG-related factors – ESG issues using risk mapping methodologies – challenges of undertaking ESG analysis across different geographic regions and cultures – challenges of identifying and assessing material ESG issues – challenges of integrating ESG analysis into a firm’s investment process – approaches taken across a range of ESG integration databases and software available.

TOTAL : 45 PERIODS

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

CO1  Explain the essential concepts, rationales, drivers and processes of Environmental, Social and Governance (ESG) in organizations

CO2  Analyze critical issues and opportunities in ESG in organizations

CO3  Enable to prepare and assess the ESG performance of an organization, the processes behind the preparation of an ESG report, and identify key material issues in relations to reporting standards

CO4  Apply the practice knowledge and skills to transform ESG from a reporting (compliance) practice into a sustainable strategy.

CO5  Create a new practice for organizations in serving the interest of the profit, public and the environment

REFERENCES:


6. Andy Gouldson, “Environmental Policy and Governance”, John Wiley & Sons Ltd, 2022


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UNIT I  GLOBAL WARMING AND CLIMATE CHANGE  9

UNIT II  CLIMATE CHANGE MODELLING AND PROJECTIONS  9
Climate change projection Scenarios and storylines -Representative Concentration Pathways and Shared Socio EconomicPathways (SSPs) - Salient features. - Modeling of the climate systems - Earths' energy budget – types, hierarchy and components of a climate model, Equations governing the atmosphere - Development of Climate models - General Circulation Models (GCMs) - Coupled Climate-Economy-Ecology-Biosphere Modeling - Issues with GCMs - Introduction to Regional Climate Models (RCMs) and Limited Area Models (LAMs) - Downscaling of Global Climate Model –selection of GCMs for regional climate change studies – Ensemble theory - selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downsampling (Statistical and Dynamical) - Bias correction – Delta method, Quantile Mapping, Salient features and limitations, Model validation and calibration- evaluating model performance- post processing - Climate Projections for India and Tamil Nadu

UNIT III  CLIMATE CHANGE IMPACTS AND ACTION FRAMEWORK  9
Climate Change Vulnerability and Risk assessment- Impact on Water Systems - Freshwater Resources - Ground water -Ocean and marine Resources - Agriculture and food security – Coastal and Terrestrial Ecosystems – Biodiversity and shift in major biomes - Forests – Health —Climate change impacts on vulnerable populations -Climate Equity and Environmental justice – Climate Action Framework – Parris agreement – NET Zero targets- Nationally determined Contributions – Climate Change Action Plan at national and State Level – National and State level Climate Change Missions and Action agenda

UNIT IV  CLIMATE CHANGE MITIGATION  9

UNIT V  CLIMATE CHANGE ADAPTATION  9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1: Understand the basics of climate parameters and their effect on climate change and Comprehend the latest IPCC climate scenarios and International Agreements and Protocols
CO2: Understand the application of climate models and downscaling approach for future climate prediction
CO3: Gain thorough knowledge on how different sectors are affected by climate change and the action plans at National and State level
CO4: Gain in-depth knowledge on climate change mitigation measures
CO5: Understand the adaptive measures to be taken on different sectors to mitigate the climate change impacts

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EM3005 SUSTAINABLE AGRICULTURE FOR ENVIRONMENTAL MANAGEMENT

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UNIT I CONCEPTS OF SUSTAINABLE AGRICULTURE

UNIT II SOIL MANAGEMENT IN SUSTAINABLE AGRICULTURE

UNIT III WATER MANAGEMENT IN SUSTAINABLE AGRICULTURE
Water storage methods- rainwater collection and storage, bore well, farm dams- criteria for farm dam design, livestock water requirements, problems with water – water quality, salinity – causes, effects – treating saline water – strategies, water saving measures – using farm wastewater – characteristics
CO1: Understand the concepts of different farming systems for sustainable agriculture
CO2: Educate to manage the problem soils using sustainable materials to improve productivity
CO3: Understand how to manage pest and disease using sustainable approaches for better yield
CO4: Gain in-depth knowledge on methods used to control weeds in agricultural systems in sustainable manner
CO5: Understand the need for sustainable agriculture and various management aspects required for sustainable agriculture

REFERENCES
2. Farmers Handbook on Basic Agriculture, Chandra Sekar et al, (Eds.), 2016
3. The complete Technology Book on Vermiculture and Vermicomposting, NPCS Board of Consultants and Engineers, Asia Pacific Business Press Inc., 2004

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UNIT I  INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE

UNIT II  BIOMASS PYROLYSIS
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III  BIOMASS GASIFICATION

UNIT IV  BIOMASS COMBUSTION
Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V  BIO ENERGY
Basic concepts of circular economy based on organics - Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1 Understand the various types of wastes from which energy can be generated
CO2 Gain knowledge on biomass pyrolysis process and its applications
CO3 Develop knowledge on various types of biomass gasifiers and their operations
CO4 Gain knowledge on biomass combustors and its applications on generating energy
CO5 Understand the principles of bio-energy systems and their features

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UNIT I ECOLOGICAL SYSTEM

UNIT II REACTOR MODELLING

UNIT III WATER QUALITY MODELLING

UNIT IV MICROBIAL DYNAMICS AND ENERGETICS

UNIT V COMPUTER BASED SOLUTION
Formulation of linear optimization models. linear programming. sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models- simulation, parameter estimation and experimental design.

COURSE OUTCOMES:
• On completion of the course, the students are able to
CO1 Apply the principle of system modeling
CO2 Do reactor modeling
CO3 Develop water quality models.
CO4 Model microbial dynamics
CO5 Apply the knowledge of numerical techniques to environmental system modeling

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UNIT I CLASSIFICATION OF TOXICOLOGY

UNIT II TOXICANTS IN ENVIRONMENT
Sources of toxic compounds – point and non-point sources, plant, animal, and mineral based toxic compounds, exposure classes, toxicants in air, water, soil, domestic and occupational environments — Endocrine disrupting compounds – Disinfectant byproducts - Pesticides – acute pesticide poisoning, movement of toxicants in the environment - types of air pollutants, particulate matter, Radioactive toxicity – sources, types and effects – types of mutation - Applicable standards and exposure guidelines - Techniques for evaluating potential exposures, food additives and flavors – toxins from microorganisms and their effect.

UNIT III MECHANISM OF ACTION OF TOXICANTS

UNIT IV METABOLISM OF TOXICANTS
Metabolic reactions involving toxicants, physiological effects, genetic effects, environmental effects, nutritional effects of toxicants. Environmental persistence, degradation, accumulation, Biotransformation – Sites of biotransformation – Cytochrome system P - 450 dependent oxidative reactions, Non cytochrome P-450 dependent oxidations – Reduction, hydrolysis reactions, Factors affecting biotransformation – enzyme induction, enzyme inhibitors, genetic variation, age.

UNIT V TOXICITY TESTING AND RISK ASSESSMENT
Toxicity testing in animals —acute toxicity, chronic toxicity testing studies, Animals used for toxicity testing studies – Exposure mode, species differences, Risk assessment – Additivity, synergy, antagonism, Risk assessment tests - bacterial mutagenesis test, Ames assay, DNA repair assay, mammalian mutagenicity assay, mammalian cell chronic cytotoxicity assay, exposure assessment, prevention of toxicity, human health risk, exposure and characterization of risk and management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1 Explain the basic importance of toxicology and its applications in different fields
CO2 Understand and describe the type of toxicants in the environment, their effects and evaluation techniques
CO3 Select and apply appropriate methods for assessing the toxicity of a compound in the environment
CO4 Explain factors affecting biotransformation and the metabolism of toxic compounds
CO5 Conduct testing and research on risk assessment, understand the importance of test animals in toxicity testing studies

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**EM3009 ENVIRONMENTAL BIOTECHNOLOGY**

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**UNIT I BASIC CONCEPTS OF ENVIRONMENTAL BIOENGINEERING**

Environmental issues – land, soil, water; Environmental Biotechnology for safer Environment – Microbial Communities of Environmental Engineering systems, Interaction of biological species in the environment – Types of interactions, factors affecting the interaction, transformation and removal of heavy metals, processing of solid waste, development of biopesticides – Current status, scope

**UNIT II BIOTECHNOLOGY FOR ENVIRONMENTAL MONITORING AND RESOURCE MANAGEMENT**


**UNIT III BIOTECHNOLOGY AND BIODIVERSITY CONSERVATION**

Basic concepts – factors affecting biodiversity, biodiversity extinction, threats to biodiversity, climate change and biodiversity, biological invasions – biodiversity indices – Biodiversity conservation strategies - Germplasm/gene bank, tissue culture, Global and indigenous approaches to conserve biodiversity, International programs for biodiversity conservation, Biodiversity improvement, sources of genetic variation, Population genetics – Hardy - Weinberg equilibrium, Molecular approaches to assess biodiversity, Molecular maps and markers – Random Amplified Polymorphic DNA (RAPD), Restriction Fragment Length Polymorphism (RFLP), Amplified Fragment Length Polymorphism (AFLP), DNA fingerprinting.
UNIT IV  MOLECULAR BIOLOGY AND GENETIC ENGINEERING


UNIT V  BIOTECHNOLOGY FOR A CLEAN ENVIRONMENT

Biotechnology approaches for environmental remediation – Whole organism – approach, bio substitutions – types, Phytoremediation, mycoremediation, wastewater treatment, bioleaching, Production of clean fuel, biopolymers, bioenzymes, biofertilizers, biofilters; Biotechnical pathways of hazardous waste remediation, Integrated Environmental Biotechnology – methods, Case studies.

TOTAL: 45 PERIODS

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

CO1 Understand the importance of biotechnology and the associated process occurring in the environment for safer environment
CO2 Explain the significance of biotechnology and the indicators for environmental monitoring and resource management
CO3 Understand importance of biodiversity for the healthy environment and the biotechnology and molecular biology techniques to protect the biodiversity
CO4 Conduct research on Recombinant DNA technology to develop organisms survive in adverse conditions and polluted environment
CO5 Understand the various biotechnology approaches and techniques to maintain clean and healthy ecosystem

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DIRECTOR
UNIT I  ENVIRONMENTAL MANAGEMENT STANDARDS  9

UNIT II  PREVENTIVE ENVIRONMENTAL MANAGEMENT  9
Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner productionand Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification – Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries – Preventive Environmental Management over Product cycle.

UNIT III  ENVIRONMENTAL MANAGEMENT SYSTEM  10

UNIT IV  ENVIRONMENTAL AUDIT  8
Environmental management system audits as per ISO 19011-Internal Audits and Certification Audits – Principles of auditing- Roles and qualifications of auditors - Determining auditor competence- Managing an audit programme – Establishing and Implementing audit programme- Selecting audit team members and Assigning responsibility Conducting an audit- opening meeting, Audit evidence gathering - Collecting and verifying information - Managing and maintaining audit programme records- closing meeting and reporting - Non conformance – Corrective and preventive actions - Continual improvement -compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit – ISO 14064 & IS 50001.

UNIT V  CASE STUDIES  9
Case studies on applications of EMS, Life cycle Assessment, , Waste Audits and Pollution Prevention in Textile industry , Tanning industry, Electroplating, Pulp & Paper, Dairy, Chemical industries and service organizations, automobile sector, cement industry, steel and Aluminium Manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to
- CO1 Explain the various elements of Corporate Environmental Management systems and audits complying to international environmental management system standards
- CO2 Apply the knowledge of science and engineering fundamentals to pollution prevention assessment and environmental performance evaluation
- CO3 Develop environmental management systems for organisations
CO4 Conduct environmental management system audits taking into account the sustainability context

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

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

UNIT I MEMBRANE FILTRATION PROCESSES 10
Membrane filtration for solid Liquid separation- crossflow filtration–History of Development and Recent advancements- Basic terms and principles- Recovery, Flux, Rejection, Fouling - membrane flux and trans membrane pressure-Theory of membrane separation– mass transport characteristics–porous and non porous filtration models – concentration polarisation types and choice of membranes –membrane structures and materials – plate and frame, spiral wound and

UNIT II MEMBRANE SYSTEMS


UNIT III MEMBRANE BIOREACTORS

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

UNIT IV PRETREATMENT AND POST TREATMENT SYSTEMS


UNIT V CASE STUDIES


TOTAL: 45 PERIODS

COURSE OUTCOMES:

• On completion of the course, the student is expected to be able to
  
  CO1 Explain the various main membrane processes, principles, separation mechanisms, and applications
  
  CO2 Apply the knowledge of science and engineering fundamentals to analyse the mechanisms of membrane filtration
  
  CO3 Design of membrane systems involving microfiltration, ultrafiltration, nanofiltration, reverse osmosis, electrodialysis and membrane bioreactor processes
  
  CO4 Select appropriate membrane technologies for water and wastewater treatment taking into account the impact of the solutions in a sustainability context
  
  CO5 Conduct research pertinent to membrane technology applications to water and wastewater treatment and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

1. Mihir K. Purkait, Randeep Singh, Membrane Technology in Separation Science, CRC Press, 2018
5. Hee-Deung Park In-Soung Chang Kwang-Jin Lee, Principles of Membrane Bioreactors for Wastewater Treatment, CRC Press, 2015

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EM3010          ENVIRONMENT, HEALTH AND SAFETY IN INDUSTRIES          L T P C
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UNIT I          INTRODUCTION          9
Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives - Ergonomics.

UNIT II          OCCUPATIONAL HEALTH AND HYGIENE          9
Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria

UNIT III          WORKPLACE SAFETY AND SAFETY SYSTEMS          9

UNIT IV          HAZARDS AND RISK MANAGEMENT          9

UNIT V          ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT          9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the students are expected to be able to understand:
CO1 Need for EHS in industries and related Indian regulations
CO2 Various types of Health hazards, effect, assessment and control methods
CO3 Various safety systems in working environments
CO4 The methodology for preparation of Emergency Plans and Accident investigation
CO5 EHS Management System and its elements

REFERENCES:


EM3011  INDUSTRIAL ECOLOGY  LT P C 3003

UNIT I  INTRODUCTION TO INDUSTRIAL ECOLOGY  9
Origin of IE, its definition, Goals and concepts, the environment and the anthrosphere, industrial systems, material resources, societal factors and environmental equity. Link to sustainable development. Goals and concepts Systems analysis, industrial metabolism, biological analogies, material and energy flow and their transformations, closing the materials cycle (open vs. closed-loop systems)

UNIT II  ENVIRONMENTAL MANAGEMENT AND SUSTAINABILITY FRAMEWORKS  9

UNIT III  INDUSTRIAL ECOSYSTEMS AND KEY ISSUES IN ECO-INDUSTRIAL DEVELOPMENT  9
Components of an industrial ecosystem (Kalundborg example), industrial symbiosis, role of government, community, developers, management, evaluating the success of eco-industrial development-industrial symbiosis

UNIT IV  LIFE CYCLE ANALYSIS  9
Life cycles of products, processes and facilities; life cycle assessment (components, methodology, applications, difficulties), Inventory Analysis, Energy and Transportation Modeling, design for environment, efficient use of material (remanufacturing, recycling, reuse, etc) Phases, Life Cycle Impact Assessment

UNIT V  LIFE CYCLE DESIGN AND MANAGEMENT  9
Accounting - Internal costs: conventional, hidden, liability, less tangible costs; external costs, Activity Based Accounting and Cost allocation, Revisit Sourcing Decisions, Extended Producer Responsibility, E Waste, Decision-making Frameworks, Success stories, Environmental Marketing & Labeling

TOTAL 45 PERIODS

COURSE OUTCOMES:
On completion of this course, students should be able to:

CO1: Articulate the core philosophy and principles of industrial ecology as it is practiced globally. Identify the benefits and limitations of tools like materials flow analysis, design for environment, environmentally extended input-output analysis, and process-based life-cycle assessment.

CO2: Differentiate and choose appropriately among tools for measuring environmental impacts of industrial systems.

CO3: Relate the concepts of reverse logistics, industrial symbiosis, and biomimicry to design solutions for sustainability problems in the industrial system.

CO4: Apply and operate screening-level life cycle assessment tools and software in case studies for product and packaging design.

CO5: Conduct a comparative environmental life cycle assessment (LCA) in support of a decisions with respect to design, operations, or policy making for products, products systems, or infrastructure in the industrial system.

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EM3012 ENERGY MANAGEMENT IN INDUSTRIES LT P C 3 0 0 3

UNIT I INTRODUCTION 8

UNIT II AUDITING AND INSTRUMENTATION IN ENERGY MANAGEMENT 9
Energy Audit – Purpose, Types, Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries; Energy Audit Questionnaire - Role of instrumentation in energy conservation - total energy systems - concept of total energy advantages, limitations & Application.

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UNIT III ENERGY MANAGEMENT

UNIT IV ENERGY ECONOMICS

UNIT V APPLICATIONS
Case studies on sugar Industry –Co generation, Thermal power plant; Petrochemical Industries

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  CO2 Understand principles of Energy Audit and Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries;
  CO3 Understand various Energy management Measures in Steam Systems
  CO5 Plan energy management measures for sugar Industry – Co generation, Thermal power plant; Petrochemical Industries based on similar case studies.

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EN3051 MARINE POLLUTION AND CONTROL

UNIT I MARINE AND COASTAL ENVIRONMENT
Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features — beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes — the oceans and climate, coastal zone regulation in india — national and international treaties.
UNIT II OCEAN HYDRODYNAMICS
Wave theory, waves in shallow waters — refraction, diffraction and shoaling, approximations for deep and shallow water conditions — tidal classification - general circulation of ocean waters - ocean currents - coastal sediment transport - onshore offshore sediment transport – beach formation and coastal processes - Tsunamis, storm surge, El Nino and La Nina effect.

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

UNIT IV MARINE POLLUTION MONITORING

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

TOTAL: 45 PERIODS

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

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UNIT I  ELEMENTS OF REMOTE SENSING  9
Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features,

UNIT II  REMOTE SENSING TECHNOLOGY  9
Classification of Remote Sensing Systems, Aerial photographs, Scanning – Acrosstrack and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR

UNIT III  SATELLITE REMOTE SENSING  9
Satellites and their orbits, Satellite sensors, Indian space Research and development - ISRO satellites, LANDSAT, ERS, SPOT, TERRA and NOOA satellite series, Characteristics of Remote Sensing data, Satellite data Products

UNIT IV  REMOTE SENSING APPLICATIONS AND CASE STUDIES  9
Visual image interpretation, Digital image processing – Image rectification, Enhancement, transformation, Classification, Data merging – Remote sensing applications in Monitoring and management of environment - Conservation of resources, Disaster management, Sustainable urban land use, Agriculture, EIA, Marine and Coastal zone management – Case studies

UNIT V  GEOGRAPHICAL INFORMATION SYSTEM AND CASE STUDIES  9
GIS - Concepts and components, Spatial and non-spatial data, Vector and raster data structures, Data analysis, Database management – RS – GIS Integration, Image processing software, GIS software GIS applications in Monitoring and management of environment - Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students are able to
CO1 Know about the remote sensing principle and the different stages of remote sensing
CO2 Understand the various type remote sensing technology.
CO3 Apply the knowledge of satellite sensing system for different environmental issues.
CO4 Apply the knowledge of GIS and image analysis for environmental applications.
CO5 Develop the GIS data base. And work with multi-disciplinary team.

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* 1-low, 2-medium, 3-high
UNIT I  ELEMENTS OF OPERATION AND MAINTENANCE
Strategy for good operation and maintenance- preventive and corrective maintenance scheduling - operation and maintenance Plan - proper and adequate tools, spare units and parts - training requirements- laboratory control- records and reports- housekeeping – sampling procedure- analytical techniques- code of practice for analytical laboratories- measurement of flows, pressures and Levels -safety in O&M operations - management information system - measures for conservation of energy

UNIT II  OPERATION AND MAINTENANCE OF WATER SUPPLY SYSTEMS
Operational problems, O&M practices and records of operation of reservoir and intakes - causes of failure of wells- rehabilitation of tube wells & bore wells- prevention of incrustation and corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance of water pumps - problems in the water distribution system and remedies- water quality monitoring and surveillance

UNIT III  OPERATION AND MAINTENANCE OF SEWERAGE SYSTEMS

UNIT IV  OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENT UNITS
Operation and maintenance in screen chamber, grit chamber and clarifiers- operation issues, trouble shooting guidelines and record keeping requirements for clarifier, equalization basins, neutralization unit - chemical storage and mixing equipment - chemical metering equipment - flash mixer -filters, thickeners and centrifuges- filter press - start-up and maintenance inspection - motors and pumps - hazards in chemical handling – jar test -chlorination equipment - membrane process systems- SDI and LSI determination- process chemistry and chemical dosage calculations - SOP-case studies

UNIT V  OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS
Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- startup and shutdown procedures-DO, MLSS and SVI monitoring- trouble shooting guidelines –planning, organizing and controlling of plant operations – capacity building, case studies of retrofitting- SOP-case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1 Understand the O&M issues pertaining to STP and WTP
CO2 Understand operation and maintenance of water intakes and supply systems
CO3 Recognize the O&M issues relevant to sewerage system
CO4 Understand operation and maintenance of physico-chemical treatment units
CO5 Understand operation and maintenance of biological treatment units

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* 1-low, 2-medium, 3-high

EM3014 SLUDGE AND SEPTAGE MANAGEMENT L T P C 3 0 0 3

UNIT I SOURCES AND CHARACTERISTICS OF SLUDGE 9
Objectives of sludge treatment – sources of sludge- Sludge from WTP, STP and CETP- Sludge-Quantification-generation from various treatment plants – Characteristics in each stage of treatment —Physico-chemical and biological- Mass balance in sludge treatment

UNIT II SLUDGE THICKENING AND DEWATERING 9
Sludge thickening- Gravity thickening - Drum thickener - Air floatation – Centrifugation-conditioning - Sludge Dewatering- Centrifuge- Vacuum Filtration- Sludge drying bed- performance of thickener and dewatering systems-operation and maintenance

UNIT III SLUDGE STABILIZATION 9
Objectives-Aerobic and Anaerobic Sludge digestion processes – Types of anaerobic digesters – design of Low rate and High-rate digesters – Two stage digester-Aerobic digestion- Pure oxygen and thermophilic aerobic digestion - Chemical and Thermal stabilization process

UNIT IV REUSE AND LAND APPLICATION OF SEWAGE SLUDGE 9
Introduction- beneficial use-requirements and associated risks-handling and management- storage - operation aspects of transport and application of biosolids application land- Lagoon- Landfilling- land farming- Composting- windrow composting - Vermicomposting - Laws and regulations on sludge management

UNIT V SEPTAGE MANAGEMENT 9
Sources of Septage – characteristics- Public health and environmental hazards- Elements ofseptage management- Pumping and Desludging Septic Tanks-Transportation- Treatment- Dewatered septage sludge reuse- Operation and maintenance - Planning and implementation of septage management schemes-Case studies

TOTAL : 45 PERIODS
COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  
CO1  Understand sources and characteristics of various sources of sludge.
  
CO2  Design sludge thickening and dewatering units
  
CO3  Design of sludge stabilization units
  
CO4  Know about the requirements and associated risk while reusing sewage sludge
  
CO5  Plan and implement septage management scheme

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* 1-low, 2-medium, 3-high

EM3015  RURAL WATER SUPPLY AND ONSITE SANITATION  L T P C

UNIT I  DEVELOPMENT OF WATER SOURCES  9
Sources of water — Alternate ways of water supply- Issues of water supply in rural areas- Surface and ground water sources – Traditional drinking water ponds- Development of deep bore wells- Estimation of yield-- Rain water harvesting – sanitation of rural wells - Types and selection of pumps for rural wells – system performance- Construction –Operation and maintenance.

UNIT II  WATER TREATMENT  9

UNIT III  SANITATION AND PLUMBING  9

UNIT IV  DECENTRALISED WASTEWATER TREATMENT SYSTEMS  9
Fundamentals of sewage treatment- Decentralized sewage treatment- Ecology and self- purification effect-Septic tank with soil absorption systems - DEWATS components- Design of anaerobic baffled
reactors—Constructed wetland—Design aspects of vertical and horizontal flow planted gravel filters—Operation and maintenance.

UNIT V  SEPTAGE MANAGEMENT
Sources of Septage – characteristics—Elements of septage management—Pumping and Desludging Septic Tanks—Transportation—Treatment—Operation and maintenance—Planning and implementation of septage management schemes—Case studies

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  CO1  Ability to identify alternate sources of water for rural water supply scheme
  CO2  Develop conceptual schematics required for the treatment of water for rural application.
  CO3  Ability to function on a multi-disciplinary team.
  CO4  Capability to identify pertinent criteria for the design of DEWATS system
  CO5  Understand septage management

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