DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI

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 programme ME Environmental Engineering will

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

PEO2 Become consultants on complex real life Environmental Engineering problems related to water supply, sewerage, sewage treatment, solid waste management, air pollution control, environmental impact assessment, industrial pollution control.

PEO3 Become entrepreneurs 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 Perform investigation for solving environmental problems by conducting research using modern equipment and software tools.

PEO5 Function in multi-disciplinary teams and advocate policies, systems, processes and equipment for control and remediation of pollution.

PROGRAMME OUTCOMES

Graduates of the programme ME Environmental Engineering will be able to

1. PO An ability to independently carry out research/investigation and development work to solve practical problems

2. An ability to write and present a substantial technical report/document

3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

4. Critically analyze complex Environmental Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

5. Conceptualize and solve Environmental Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio cultural factors.

6. Develop ability to engage in independent and life-long learning to improve competence by critical examination of the outcomes of one’s actions in addressing Environmental issues and learning from corrective and preventive measures.
PEO/PO Mapping:

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**TOTAL CREDITS 29**

[Stamp: Director, Centre for Academic Courses, Anna University, Chennai-600 025]
### PROFESSIONAL ELECTIVE COURSES [PEC]

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### Summary

**NAME OF THE PROGRAMME: M.E ENVIRONMENTAL ENGINEERING**

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UNIT I ENVIRONMENTAL DATA 12
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 12
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 12
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 12

UNIT V APPLICATIONS AND CASE STUDIES 12
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:

10
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• 1-low, 2-medium, 3-high

EN3101 ENVIRONMENTAL CHEMISTRY

UNIT I FUNDAMENTALS
Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp), heavy metal precipitation, amphoteric hydroxides, CO$_2$ solubility in water and species distribution – Ocean acidification, Chemical kinetics, First order and pseudo order examples- 12 Principles of green chemistry

UNIT II AQUATIC CHEMISTRY
Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of natural and synthetic chemicals - Metals, complex formation, oxidation and reduction, pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation.

UNIT III ATMOSPHERIC CHEMISTRY

UNIT IV SOIL CHEMISTRY
Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

UNIT V EMERGING TRENDS
Chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals- Pesticides, Dioxins & Furan, PCBs, PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites, environmental applications, Green Hydrogen generation.

List of experiments
1. Calibration of pipette and estimation of SD and CV
2. Calibration and Measurement of pH, EC and turbidity of water sample
3. Estimation of Chloride in Water sample by volumetric titration
4. Determination of fluoride in water by spectrophotometric/Ion selective method
5. Determination of sulphate of water sample by spectrophotometric method
6. Determination of colour in water and wastewater samples
7. Determination of phosphate by molybdenum blue method
8. Determination of Total Solids, Total suspended solids, Total dissolved solids by gravimetry
9. Determination of COD in wastewater sample
10. Sampling and determination of BOD in the wastewater sample
11. Sampling and determination of ammonia/TKN in wastewater sample
12. Sampling and characterization of soil for Na and K
13. Sampling and characterization of solid waste for Moisture, organic and inorganic matters

TOTAL: 105 PERIODS
COURSE OUTCOMES:
CO1: Students will gain competency in solving environmental issues of chemicals based pollution
CO2: Ability to determine chemicals mobility in aquatic systems
CO3: Ability to identify contaminating chemicals in air and their fate
CO4: Understand the type of soil contaminants and provide remediation
CO5: Identify emerging environmental contaminants and nano tech applications including green hydrogen

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

EN3102  ENVIRONMENTAL MICROBIOLOGY  

UNIT I  FUNDAMENTALS OF MICROBIOLOGY  
Classification of microorganisms – prokaryotic, eukaryotic, ultra-structure of cell – Gram positive, Gram negative, characteristics, importance, introduction to water, soil and air borne pathogens and parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, bacteriophages – lytic and lysogenic cycles, concentration and detection of virus, isolation, characterization of bacteria, preservation, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

UNIT II  MICROBIAL DIVERSITY AND NUTRIENTCYCLING  

UNIT III  METABOLISM OF MICROORGANISMS  
UNIT IV MICRROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS


UNIT V TOXICOLOGY

Ecotoxicology – toxicants and toxicity, factors influencing toxicity. effects – acute, chronic, test organisms – toxicity testing - lab and field testing methods, bioconcentration – bioaccumulation and biomagnification – causes, effects, bioassay, biomonitoring – techniques, considerations for designing biomonitoring studies, ethical aspects, issues - biomarkers in environmental monitoring.

LIST OF EXPERIMENTS

1. Preparation of culture media (Broth and Solid)
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)
4. Measurement of growth of microorganisms
5. Analysis of air borne microorganisms
6. Staining of bacteria (Gram Staining technique)
7. Effect of pH, temperature on microbial growth
8. Bacteriological analysis of wastewater (Coliforms, *E. coli*, Streptococcus) – MPN
9. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques
10. Effect of Heavy metals on microbial growth
11. Detection of anaerobic bacteria
12. Bioreactors (cultivation of microorganisms)

TOTAL: 105 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1: Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights
CO2: Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.
CO3: Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes
CO4: Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.
CO5: Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

REFERENCES

2. Bhatia S.C., "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 20083
3. Gabriel Bitton, Wastewater Microbiology, 2nd Edition,
EN3103 DESIGN OF PHYSICO-CHEMICAL TREATMENT SYSTEMS FOR WATER AND WASTEWATER

UNIT I INTRODUCTION 5

UNIT II TREATMENT PRINCIPLES 10

UNIT III DESIGN OF MUNICIPAL WATER TREATMENT PLANTS 10

UNIT IV DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS 10

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 10

TOTAL: 45 PERIODS
COURSE OUTCOMES:
- On Completion of the course, the student is expected to be able to

CO1 Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design

CO2 Describe the principles of physico-chemical treatment systems and choose the relevant treatment systems for effective water and wastewater treatment

CO3 Design the treatment scheme for municipal and industrial water, wastewater to meet the specific needs on residue management

CO4 Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable

CO5 Conduct research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems in collaboration with municipalities, corporation, pollution control boards and industries

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• 1-low, 2-medium, 3-high
UNIT II  WATER TRANSMISSION MAINS
Planning of water system – design of storage reservoirs - water transmission main design- compound gravity and pumping main; selection of pumps and characteristics curve - economics; specials, jointing, laying and maintenance, water hammer analysis; Surge Analysis-importance, protection, software analysis

UNIT III  WATER DISTRIBUTION
Service reservoirs-types and design. water distribution pipe networks design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection. plumbing for water supply in high rise buildings. use of computer software in water transmission, water distribution design – EPANET 2.0, LOOP version 4.0, BRANCH,

UNIT IV  WASTEWATER COLLECTION AND CONVEYANCE
Planning factors – design of sanitary sewer; partial flow in sewers, economics of sewer design; wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters. plumbing for drains in high rise buildings-Combined Sewers

UNIT V  STORM WATER DRAINAGE
Necessity- combined and separate system; estimation of storm water runoff - formulation of rainfall intensity duration and frequency relationships- rational methods. CPHEEO model Design; Use of computer softwares in sewer design–sewer. SewerCAD, SewerGEMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On Completion of the Course the student will be able to
  CO1 Understand general hydraulics and need for proper collection and conveyance of water and wastewater
  CO2 Design economic diameters of gravity and pumping mains and storage reservoirs
  CO3 Design and analysis of water distribution networks and apply computer softwares
  CO4 Design sewer networks for various flow conditions
  CO5 Design storm water drain and apply computer softwares for design of sewers.

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- 1-low, 2-medium, 3-high
UNIT I RESEARCH PROBLEM FORMULATION
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
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING
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, methodology, 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
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , 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
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.

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

TOTAL: 45 PERIODS

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
UNIT I  REACTION KINETICS AND BIO REACTORS  12

UNIT II  CONVENTIONAL AEROBIC TREATMENT PROCESSES  12

UNIT III  ADVANCED AEROBIC TREATMENT PROCESSES OF WASTEWATER  12
Sequencing batch reactors- moving bed biofilm reactors- membrane bioreactor- reclamation and reuse of wastewater-design of tertiary treatment units-application of membrane separation technologies in reuse of sewage -case studies

UNIT IV  ANAEROBIC TREATMENT OF WASTEWATER  12
Attached and suspended growth process -design of units–UASB – post treatment systems for UASB reactor-anaerobic filters – expanded bed and fluidized bed anaerobic systems -septic tank and soil disposal system - anaerobic baffled reactor–anaerobic sludge digestion process -types of anaerobic sludge digesters – design of low rate and high rate anaerobic digestors- recent trends.

UNIT V  NUTRIENT REMOVAL SYSTEMS  12

TOTAL: 60 PERIODS

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  CO1 Understand the microbial process and its kinetics
  CO2 Design and size the different components of conventional aerobic treatment systems.
  CO3 Design and size the different components of advanced aerobic treatment systems.
  CO4 Understand in detail about the anaerobic treatment of wastewater which includes the design of attached and suspended growth processes.
  CO5 Design the different elements of nutrient removal systems

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

UNIT I INTRODUCTION 8

UNIT II INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION 8
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 10

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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1-low, 2-medium, 3-high

EN3211  ENVIRONMENTAL AND PROCESSES MONITORING LABORATORY    L T P C
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EXCERCISES
1. Coagulation and Flocculation
2. Batch studies on settling
3. Studies on Filtration- Characteristics of Filter media
4. Water softening
5. Adsorption studies/Kinetics
6. Langelier Saturation Index and Silt Density Index- For Membrane Filtration
7. Kinetics of suspended growth process (activated sludge process)-and Sludge volume Index
8. Sludge Filterability Test
9. Anaerobic Reactor systems / kinetics (Demonstration)
10. Advanced Oxidation Processes – (Photo catalysis)
11. Disinfection for Drinking water (Chlorination)
12. Ambient Air Sampling-Determination of PM10, PM2.5, SO2 and NO2
13. Noise Monitoring-Determination of Equivalent Noise Level

TOTAL: 90 PERIODS
COURSE OUTCOME:
After the completion of the course the students will be able

CO1 Able to determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics

CO2 Able to determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants

CO3 Able to Determine Equivalent Noise Level by noise monitoring

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

SYLLABUS CONTENT
The students have to select any advanced topic of their choice related to Environmental Engineering, 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.

TOTAL: 30 PERIODS

COURSE OUTCOME:

CO1 Identify various innovative and latest advancements in the Environmental field through research studies.

CO2 Improve their communication skills and Understand the art of writing research work through analysis of a specific topic in the related field.

CO3 Learn to make good presentation and explain a concept.

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* 1-low, 2-medium, 3-high
EN3311  PRACTICAL TRAINING (4 WEEKS)  L T P C
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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
• 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:
CO1 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
CO2 Develop knowledge in analysing and understand the professional ethics
CO3 Solve Environmental related problems in the field either individually or in team

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EN3312  PROJECT WORK I  L T P C
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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.

COURSE OUTCOME:
students will be able to
CO1 Identify Environmental engineering 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 engineering problems
CO3 Apply engineering and management principles through efficient handling of the project and
demonstrate a sound technical knowledge of their selected project topic

TOTAL: 180 PERIODS
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EN3411 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 engineering 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 engineering 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

EN3001 AIR QUALITY MODELLING

UNIT I MODELLING AND MODELS
Overview of different types of models-deterministic and stochastic approach- steps in model development- numerical and simulations models- calibration and validation of models- limitations- transport phenomena- mass balance analysis-model development and decision making. Types of air quality models-classification

UNIT II METEOROLOGY AND DISPERSION
Chemistry of air Pollutants - atmospheric reactions, sinks for air pollution –transport of air pollutants - meteorological factors for dispersal of air pollutants – meteorological modelling-developing wind rose and pollutant rose diagrams-vertical structure of temperature and stability, mixing height; tall
stacks-transport and diffusion of stack emissions –plume segments–flare stack–plume rise equations-Holland’s and Brigg’s models.

UNIT III EMISSION AND SOURCE DISPERSION MODELS
modeling for reactive and nonreactive pollutants, point source-single and multiple sources- area sources, line source models, fixed box models- diffusion models – Gaussian plume derivation-modifications of Gaussian plume equation- Gaussian puff model- emission models-emission factors-long term average-multiple cell model-accuracy and utilization-limitations-air quality mapping

UNIT IV RECEPTOR MODELS AND INDOOR AIR QUALITY MODELS

UNIT V SOFTWARE PACKAGE APPLICATIONS
Demonstration of Air Quality Model Softwares- ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSPLIT, INDEX

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- At the end of the course the student will be to

CO1 Concepts and types of models, model development, their applicability and limitations.

CO2 Understand the physicochemical transformation of air pollutants in the atmosphere along with the meteorological influence in dispersion of pollutants.

CO3 Identifies emission source and applies suitable modeling tools to estimate the impact of the pollutants.

CO4 Fetch knowledge on source inventories, model prediction efficiency and potential risk assessment.

CO5 Understand the application of models to predicts the air quality scenarios for different conditions and find suitable mitigation measures.

REFERENCES:

3. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004

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UNIT I INTRODUCTION

UNIT II HOMOGENEOUS AOPs
Photochemical AOPs – Utilization different Photocatalysts in Photocatalysis - Ozonation, O$_3$ - Ultraviolet radiation, UV Ultraviolet radiation in the presence of Hydrogen Peroxide, UV/H$_2$O$_2$ - Oxidation in the presence of Iron(III) or Iron(II) salts and hydrogen peroxide, H$_2$O$_2$ (Fenton and photo-Fenton oxidation) – Electrochemical Oxidation.

UNIT III HETEROGENEOUS AOPs

UNIT IV AOP ENHANCEMENT TECHNIQUES
Enhanced Fenton process – Hydroxyl radical based AOPs - Sulfate radical ion based AOPs – Electrical discharge plasma for water treatment - Zerovalent iron nanoparticles and ferrates in advanced oxidation processes - Y-rays, electron beams, Quantum yield improvement by Additional Oxidants - Hydrogen peroxide per sulphate – Catalyst modification – Case studies and application of semiconductor photolysis – Hybrid AOPs.

UNIT V INDUSTRIAL APPLICATIONS AND ECONOMIC ASSESSMENT OF AOPs

TOTAL: 45 PERIODS

COURSE OUTCOME:
On Completion of the course, the student is expected to be able to

CO1 Comprehend the basic principles of advanced water treatment processes, capabilities/constraints of their application in water and wastewater treatment

CO2 Apply technical knowledge and skills on the design and operation of AOPs for the water and wastewater treatment

CO3 Design suitable pre-treatment scheme, post treatment scheme, and cleaning protocols for AOPs

CO4 Explain the mechanism of AOP processes in different applications in environmental protection and conduct economic assessment on AOTs for water and wastewater treatment

CO5 Develop innovative and economically viable technologies in AOP to treat wastewater contaminated with toxic pollutants.

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**EN3003 ENVIRONMENTAL AND SUSTAINABILITY PLANNING**

**UNIT I**

**INTRODUCTION**

Principles of Environmental and Sustainability planning – Indicators of Sustainability - Sustainability Strategies - Barriers to Sustainability – Environmental Planning process - Ethical issues in environmental planning - Environmental approaches to design and Planning - Socio Economic Policies.

**UNIT II**

**PLANNING FOR SUSTAINABLE PUBLIC HEALTH AND EQUITY**


**UNIT III**

**PLANNING FOR NATURAL AREAS AND LANDSCAPES**


**UNIT IV**

**PLANNING FOR THE BUILT ENVIRONMENT**


**UNIT V**

**PLANNING FOR POLLUTION PREVENTION**


**TOTAL: 45 PERIODS**
COURSE OUTCOME:
On Completion of the course, the student is expected to be able to

CO1 Explain the principles of Environmental planning process and identify the issues in environmental designing and planning

CO2 Apply the technical planning skills for integrated water and wastewater management

CO3 Identify the environmental hazards and adapt mitigation measures for sustainable public health

CO4 Develop the integrated models and tools for environmental protection

CO5 Conduct research to develop emerging technologies for pollution prevention

REFERENCES:
2. Bradley A.S, Adebayo A.O, Maria P., Engineering Applications in Sustainable esign and Development, Cengage learning

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EN3004 AQUATIC ECOSYSTEM AND CONSERVATION L T P C

UNIT I BASIC CONCEPTS OF AQUATIC ECOSYSTEMS 9

UNIT II FRESHWATER ECOSYSTEM 9

UNIT III MARINE AND COASTAL ECOSYSTEMS 9
and pharmacological bio resources – Drugs from marine plants and animals – Biodiversity in Arctic and Antarctic oceanic environment.

UNIT IV ECOLOGICAL ADAPTATION OF AQUATIC FAUNA AND FLORA


UNIT V AQUATIC ECOSYSTEM MONITORING


COURSE OUTCOME:
On Completion of the course, the student is expected to be able to

CO1 Identify the causes of aquatic ecosystem degradation and eliminate or remediate the issues and Summarise the national and international laws on aquatic environment

CO2 Compare issues and strategies in ecosystem management between freshwater, coastal, and marine system

CO3 Describe the impact of human activities on natural aquatic environments and current management tools that are being implemented to restore or protect aquatic ecosystems

CO4 Apply natural solutions and bioengineering techniques for erosion control and bank stabilization, flood mitigation, and water treatment.

CO5 Assess the current situation (including the identification of conflicts and priorities), formulate visions, set goals and targets, and orient operational management

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UNIT I INTRODUCTION

UNIT II POLLUTANTS AND REACTIONS IN ENVIRONMENT

UNIT III REACTORS MODELLING AND DESIGN
Ideal systems modeling and design, reactor concepts, ideal reactors, reaction rate measurements, hybrid system modeling and design, sequencing batch reactor, reactors in series and reactors in recycle. Non-ideal system modeling and design, non-ideal reactor behavior, RTD analysis, PFDR model

UNIT IV MASS TRANSFER AND ITS APPLICATIONS IN ENVIRONMENTAL ENGINEERING
Principles of diffusion and mass transfer between phases, Gas absorption, humidification operations, leaching and extraction, drying of solids, fixed-bed separation, membrane separation process, fluid solid surface reactions, Gas-liquid bulk phase reaction, adsorption.

UNIT V BIOLOGICAL REACTION ENGINEERING

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, graduates are expected to attain the following outcomes:
CO1: Successfully apply advanced concepts of fundamental sciences and engineering to identify, formulate, and solve complex environmental engineering problems.
CO2: design, analyze, and develop technologies to meet desired needs of society, both, professionally and ethically.
CO3: Be knowledgeable of contemporary issues and research challenges/opportunities related to chemical and environmental engineering, and engage in life-long learning to keep abreast of such issues.
CO4: Use advanced techniques, skills, and modern scientific and engineering tools for problems related to professional practice in the field of environmental reaction engineering.

REFERENCES
3. Dunn I.J, Elmar Heinzle, John Ingham, Prenosil J.E, „Biological reaction engineering“, Wiley inter
science, 2005.

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EN3006 NATURAL SYSTEMS FOR WASTEWATER TREATMENT L T P C 3 0 0 3
UNIT I INTRODUCTION TO WETLAND TREATMENT SYSTEM 9
Definition and concept of wetland - types of wetland. Wetland - ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications. Introduction to constructed wetland-types-free water surface, subsurface wetland-horizontal and vertical flow- wastewaters and their application in wetland - constructed wetland plants-media – in constructed wetland.

UNIT II CONSTRUCTED WETLAND AND REMOVAL MECHANISMS 9
Site identification- construction and design of constructed wetland, startup, operation and maintenance of wetland system-wetland hydrology- hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal- suspended solids, organic matter, nitrogen, phosphorus, pathogen and other contaminants. Reuse of treated wastewater and its applications-limitation of constructed wetland system.

UNIT III CASE STUDIES ON CONSTRUCTED WETLAND SYSTEM 8

UNIT IV DESIGN OF WASTEWATER POND SYSTEMS 10

UNIT V SLUDGE MANAGEMENT AND TREATMENT 9
Sludge quantity and characteristics - stabilization and dewatering -sludge freezing -reed beds - vermi stabilization -comparison of bed type operations -composting land application and surface disposal
of bio solids onsite wastewater systems - effluent disposal and reuse. Sludge quantity and characteristics-stabilization and dewatering-sludge freezing reed beds-vermi stabilization-Comparison of bed-type operations-composting land application and surface disposal of biosolids-on-site wastewater systems- effluent disposal and reuse.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the various aspects of wetland system, its function and its application in the treatment of wastewaters

CO2 Apply the knowledge of science and engineering to know the types of wetlands, construction and operation of wetlands, wetland hydraulics.

CO3 Understand the process of treatment of industrial wastewater using wetland system.

CO4 Understand the various pond system available for wastewater treatment. Design of pond system -removal mechanism

CO5 Manage and dispose the sludge naturally and economically.

REFERENCES:

1. EPA- Design Manual on constructed wetland and aquatic plant system for municipal wastewater treatment system


5. Constructed wetlands for industrial wastewater treatment system by Alexandros I.Stefanakis (editor), Wiley black well.2018

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EN3007    SOFT COMPUTING IN ENVIRONMENTAL ENGINEERING L T P C
            3 0 0 3

UNIT I    SOFT COMPUTING PRINCIPLES

Introduction to soft computing techniques – algorithms and flowcharts, numerical methods - solution to ordinary and partial differential equation using finite difference, finite element and finite volume methods, Environmental modeling.

UNIT II    ARTIFICIAL INTELLIGENCE

Principle of Artificial Neural Network (ANN) –perception learning rule, neural network structure – neural network operations – ANN Algorithm – genetic algorithms – Application of ANN Model to Environmental studies

UNIT III    FUZZY LOGIC IN ENVIRONMENTAL STUDIES

Fuzzy logic principles – fuzzy logic and the theory of uncertainty – fuzzy set theory – fuzzy membership function, fuzzy relations, fuzzy rule, and applications of the fuzzy logic in environmental studies – case studies
UNIT IV  DIGITAL DATA MANAGEMENT  

UNIT V  ENVIRONMENTAL MODELING SOFTWARE  

COURSE OUTCOMES:
- On completion of the course, the students are able to
  
  CO1  Understand the various computing techniques available for environmental engineering.
  CO2  Apply the principles of ANN and GA for solving environmental problems.
  CO3  Apply the principles of Fuzzy logic and for solving environmental problems.
  CO4  Work in the statistical analysis software SYSTAT.
  CO5  Employ modern advanced computing tool MATLAB software in environmental studies.

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EN3008  DESIGN OF ENVIRONMENTAL ENGINEERING STRUCTURES  

UNIT I  STRUCTURAL DESIGN INSIGHTS AND DESIGN OF PIPES  

UNIT II  DESIGN OF WATER TANKS  
IS Codes for the design of water retaining structures - design of concrete roofing systems — cylindrical, spherical and conical shapes - design of circular, rectangular, spherical and INTZE type water tanks.

UNIT III  DESIGN OF WATER TREATMENT PLANT STRUCTURES  
Structural design of screen chamber, settling tank, clariflocculators, filters and service reservoirs.
UNIT IV  DESIGN OF WASTEWATER TREATMENT PLANT STRUCTURES
Structural design of wastewater treatment units – grit chamber, aeration tank, sludge digester, UASBR, sludge thickener, sludge drying beds.

UNIT V  SPECIAL STRUCTURES
Design of masonry walls, columns and footings as per NBC and IS Codes – swimming pools, intake towers — design of cyclone separator — scrubber.

COURSE OUTCOMES:
- On completion of the course, the students are able to
CO1  Apply the principle of limit state design for concrete pipe design
CO2  Do structural design of Water tanks
CO3  Design the water treatment plant Structures.
CO4  Design the components of wastewater treatment plant structures.
CO5  Apply the knowledge of structural design to various environmental engineering structures.

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EN3051  MARINE POLLUTION AND CONTROL  L T P C
3 0 0 3

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 run-off, 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.

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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EN3009  WATER QUALITY AND MODELLING  
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UNIT I  MODELLING IN SIGHTS  
Engineers and Mathematical models - Water quality models – historical development – different types of models - steps in model development - importance of model building - calibration and verification of models – water quality – model sensitivity – assessing model performance - finite element, finite difference and finite volume methods

UNIT II  POLLUTANT TRANSPORT  
Transport phenomena — advection, diffusion, dispersion - contamination transport in surface and subsurface water - Simple transport models – steady state and time variable solutions – conservation of mass, momentum and energy balance, governing equation for contaminant fate and transport
UNIT III SURFACE WATER QUALITY MODELLING 9

UNIT IV GROUNDWATER QUALITY MODELLING 9

UNIT V WATER QUALITY MODELLING SOFTWARE 9
Exposure to surface water and ground water quality modeling software’s – MIKE21, WASP, QUAL2E and MODFLOW – demonstration – case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On completion of the course, the students are able to
  CO1 Know about the principles of water quality modelling.
  CO2 Understand the pollutant transport phenomena in surface and groundwater.
  CO3 Apply the knowledge of surface water quality modeling to predict the water quality of rivers, lakes and estuary.
  CO4 Predict the groundwater contamination transport.
  CO5 Predict water quality of surface and sub-surface water using numerical solution.

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EN3010 ENVIRONMENTAL SYSTEM ANALYSIS 3 0 0 3

UNIT I ECOLOGICAL SYSTEM 9
UNIT II  REACTOR MODELING  9

UNIT III  WATER QUALITY MODELING  9

UNIT IV  MICROBIAL DYNAMICS AND ENERGETICS  9

UNIT V  COMPUTER BASED SOLUTIONS  9

TOTAL: 45 PERIODS

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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EN3011  ENVIRONMENTAL MONITORING INSTRUMENTS  L T P C
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UNIT I  FUNDAMENTALS  9
Wet chemistry methods and their limitations-instrumental methods, selection of method- precision and accuracy, error in measuring signals- quality control & assurance- sample preservation, sample preparation and analyte isolation- Nanomaterials for Environmental Analysis
UNIT II SPECTROSCOPIC METHODS
Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace, cold vapour and hydride generation), Atomic Emission Spectrometry (AES), flame photometry and Inducted Coupled Plasma (ICP) – TOC Analyzer, Athleometer

UNIT III CHROMATOGRAPHIC METHODS
Principles, techniques and applications of GC, GC-MS, high performance liquid chromatography (HPLC) and Ion Chromatography (IC)-hyphenated techniques for environmental contaminant (trace organics) analysis, Electrophoresis, LC-MS

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS
Principles, techniques and applications of conductometry, potentiometry, coulometry, AOX Analyzer, amperometry, polarography, electro-capillary analysis, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS
Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOx, fluorescent analyzer for SO2-particulates analysis-auto analyzer for water quality using flow injection analysis. LIMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to select appropriate instrumental method for chemical analysis
CO2: Understand spectroscopic methods of analysis of pollutants
CO3: Select correct method for toxic organics estimation using chromatography methods
CO4: Understand electro and nondestructive methods of analysis
CO5: Familiar with online analyzers

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EN3052 MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT

UNIT I MEMBRANE FILTRATION PROCESSES
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 hollow fibre membranes—membrane performance factors and considerations—membrane manufacturing process.

UNIT II MEMBRANE SYSTEMS 10
Membrane module/element designs—membrane system components—design of membrane systems—design of modules, assembly, plant process control and applications—Basic Flow patterns—Arrays, recycle. Double Pass, multiple Trains—design and applications of low pressure membrane technology systems—microfiltration and ultrafiltration—design and applications of diffusive membrane technologies—nanofiltration and reverse osmosis—Normalised Permeate Flow and Salt Rejection—electrodialysis—ion exchange membranes, process design—design of membrane systems—pump types and pump selection—plant operations—economics of membrane systems

UNIT III MEMBRANE BIOREACTORS 8
Historical perspective of MBRs—bibtreatment 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 8

UNIT V CASE STUDIES 9
Casestudiesonthedesignofmembrane-based water and wastewater treatment systems—RO Design Software—zero liquid effluent discharge plants—desalination of brackish water and seawater—project implementation and project economics—environmental issues—reject management—energy recovery systems—Issues concerning system engineering—operation and maintenance issues and good operational practices

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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EN3012 EMERGING CONTAMINANTS

UNIT I SOURCES, OCCURRENCE AND REGULATORY REQUIREMENTS 10
Definition - Priority vs. emerging contaminants - Recent concerns - Major groups - Examples - Properties - Sources - Occurrence - Distribution in soils, groundwater, industrial and municipal wastewaters, aquaculture effluents, freshwater and marine ecosystems, air, food, plants, animals and human blood - Existing global regulatory frameworks and policies

UNIT II CHARACTERIZATION AND INSTRUMENTATION 7
Sampling – Sample preparation methods – Analytical protocols for detection of pharmaceuticals, personal care products, antimicrobials and antibiotics, hormones, phthalate plasticizers and degradation products, surfactants, brominated fire retardants, pesticides and nanoparticles – Analytical instruments

UNIT III ENVIRONMENTAL FATE AND TRANSPORT 9

UNIT IV REMEDIATION TECHNOLOGIES 10
Incineration - Sonolysis - Multi-phase extraction - Permeable reactive barrier - Advanced oxidation processes - Membrane based separation - Nanofiltration - Reverse osmosis - Biosorption - Bioaugmentation - Combined treatment options - Remediation endpoints - Challenges - Opportunities

UNIT V CASE STUDIES 9
Occurrence in different environmental compartments - Environmental fate and transport - Potential and known risks to human health and the environment - Effective technological and policy approaches to prevent, control and remove emerging pollutants in the environment

TOTAL: 45 PERIODS

COURSE OUTCOMES:
• On completion of the course, the student is expected to be able to:
  CO1 Explain about the different kinds of emerging contaminants, their sources, occurrence, distribution in different environmental compartments and existing regulations/policies
  CO2 Explain about the analytical techniques for the detection of emerging contaminants in environment
CO3 Explain about the environmental fate, behaviour, underlying mechanisms, human health and ecological risks of emerging contaminants, and will be able to monitor and assess the degree of environmental contamination by emerging pollutants.

CO4 Select an appropriate single and/or integrated physical, chemical and/or biological clean-up option for environments contaminated with different classes of emerging pollutants in order to achieve the target remedial endpoints.

CO5 Conduct independent research in the future pertinent to emerging contaminant pollution and remediation.

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EN3013 PROJECT FORMULATION AND IMPLEMENTATION LT P C
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UNIT I INTRODUCTION TO PROJECT FORMULATION
Concept of project formulation – Need for project formulation - Significance of project formulation – Phases in project cycle - Methods and Tools for project formulation - Search for project ideas - Screening of project ideas - Formulation of the projects: Proposal and project report preparation guidelines and models

UNIT II PROJECT FEASIBILITY ANALYSIS
Types and importance of project feasibility studies – Technical feasibility – Economic feasibility – Legal feasibility – Operational feasibility – Scheduling feasibility - Techniques for demand forecasting - Project cost determination – Sources of finance – Profitability estimates - Cash flow estimates – Project risk and uncertainties – Steps to conduct a project feasibility study

UNIT III PROJECT APPRAISAL

Attested

DIRECTOR
Project analysis as per cash flow – Net present value – Benefit-cost ratio – Internal rate of return – Key issues – Preparing project appraisal report - Case study of good appraisal

UNIT IV PROJECT FINANCING AND IMPLEMENTATION 10
Key features of project financing – Various stages of project financing: Pre-financing, financing and post-financing – Types of sponsors/ funding agencies in project financing: Industrial, public, contractual and financial – Financial evaluation of projects under (un)certainty – Project implementation procedure: Execution, measuring project progress, reporting project status, exercising management controls and user acceptance – Project planning and control techniques

UNIT V PROJECT MONITORING AND EVALUATION 8
Need and techniques for monitoring – Guide for successful project control – Different kinds of evaluation: Appraisal or ex-ante, on-going, mid-term, termination and ex-post evaluations – Evaluation criteria

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to
CO1 Explain about the project cycle, key elements in project formulation, methods and tools for project formulation
CO2 Independently execute the feasibility analysis of a project
CO3 Successfully assess the viability of a project in a more structured manner
CO4 Select appropriate funding sources and implement a project successfully
CO5 Explain about the techniques for effective monitoring and evaluation of a project

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EN3014 ENVIRONMENTAL NANOTECHNOLOGY

UNIT I NANO-BASED MATERIAL AND THEIR SYNTHESIS 9
Defining nanotechnology - Properties of nanomaterial - Major applications in nanotechnology - Types of nanoparticles - Types and properties of engineered nanoparticles - Environmental applications of nanotechnology - General method of chemical synthesis - Biological synthesis of nanomaterial - Advanced synthesis methods – Natural nanomaterial – Development of nanocomposites

TOTAL: 45 PERIODS
UNIT II  CHARACTERIZATION TECHNIQUES  8

UNIT III  NANO-BASED WASTE WATER TREATMENT TECHNOLOGY  10
Metal based nano-adsorbents - Carbon nanotubes adsorbents – Bio adsorbents (Membrane filtration) - Nanofiber membranes - Nanocomposite membranes - Nanomaterials in water treatment – Nano sorbents - Photocatalyst - Dendrimers in water treatment - Other nanomaterials in water purification - Nano-based sensing and monitoring systems - Case studies

UNIT IV  NANO-BASED TECHNOLOGIES FOR SOIL REMEDIATION AND AIR PURIFICATION  9
Nanomaterials in soil remediation - Zero-valent iron nanoparticles - Carbon-based nanomaterials - Nanomaterials based on metals and oxides - Polymer based nanomaterials - Silica-based nanomaterials - Description of nano-based technology for soil remediation - Limitations on the use of nanostructured materials in soils - Nanotechnology in air pollution control - Case studies

UNIT V  ETHICAL ISSUES OF NANOTECHNOLOGY  9
Life cycle assessment – Use and end of life effects (Emissions, fate and alterations) – Factors controlling the transport and ultimate fate of nanomaterials – Biodegradation – Contamination and risks – Exposure routes (Inhalation and potential toxicity) – Sustainable nanotechnology – Regulating nanomaterials

TOTAL: 45 PERIODS

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

CO1 Explain about the types, properties, application and synthesis of nanomaterials for environmental application

CO2 Independently execute the characterization of nanomaterials using advanced instruments

CO3 Successfully choose a viable nano-based option for water purification

CO4 Select appropriate nano-based technologies for contaminated site remediation and air purification

CO5 Explain about the risks, uncertainties and ethics of nanomaterials employed in environment sector

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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 9
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

TOTAL: 45 PERIODS

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 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.
REFERENCES:
7. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018

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EM3051 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING

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| 9       | ISO 14000 family- EMS as per ISO 14001– benefits and barriers of EMS – Understanding the organisation and its context- Understanding the needs and expectations of interested parties-
Determining the scope of the environmental management system - Leadership and commitment - Environmental policy - Organizational roles, responsibilities and authorities - Actions to address risks and opportunities - Environmental objectives and planning – Resources - Competence-Awareness - Communication - Documented Information - Operational Planning and Control - Emergency preparedness and response - Monitoring, measurement, analysis and evaluation - Management review - Life cycle Assessment - Ecolabelling, ecological and carbon footprints. - Greenhouse gas accounting, Energy accounting

UNIT IV ENVIRONMENTAL AUDIT

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 - Nonconformance – 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

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

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

REFERENCES:


TOTAL: 45 PERIODS

### CO-PO MAPPING

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

### EM3052 OPERATION AND MAINTENANCE OF WATER AND WASTEWATER TREATMENT SYSTEMS

**UNIT I** ELEMENTS OF OPERATION AND MAINTENANCE 9
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 9
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 9

**UNIT IV** OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENT UNITS 9
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 9
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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EM3053 CLIMATE CHANGE MODELLING, MITIGATION AND ADAPTATION

UNIT I GLOBAL WARMING AND CLIMATE CHANGE

UNIT II CLIMATE CHANGE MODELLING AND PROJECTIONS
Climate change projection Scenarios and storylines –Representative Concentration Pathways and Shared Socio Economic Pathways (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 downscaling (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
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

UNIT V CLIMATE CHANGE ADAPTATION

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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EM3251 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT L T P C

UNIT I INTRODUCTION 9

UNIT II IMPACT INDENTIFICATION 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
Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment and Case Studies

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

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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