

APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

EVE 110

Credits – L:T:P = 4:1:0

CIE: 50 Marks

Hours/week: 4(L) + 1(T)

SEE: 100 Marks

Course Objective

The course is an applied science course dealing with relevant aspects of chemistry and microbiology. The chemistry provides an in depth knowledge of basics of chemistry, variety of reactions and introduces equilibrium chemistry. The course also lays foundation of electrochemistry, colloidal and surface chemistry. It encompasses water and wastewater analytical and instrumental methods of analysis.

At the end of the course the students will be able to:

CO1: Identify types of chemical reactions and evaluate the feasibility of given reaction based on thermodynamics properties. List and describe types of electrodes and electrode potential. Measure pH, emf and other related parameters.
CO2: Classify colloids, discuss their properties and their environmental significance. Apply the understanding of the underlying concepts of chemistry in the design of water and wastewater treatment systems.
CO3: Apply the knowledge of instrumental analytical techniques for measuring different types of environmental pollutants. Discuss the need for microbiology and identify different flora and fauna of importance in water, air and soil media.
CO4: Distinguish bacterial metabolic processes as applied to aerobic, anaerobic and facultative modes. Apply various growth models and determine biokinetic coefficients. Solve numerical problems on generation time, specific growth rate and decay rate.
CO5: Distinguish between algae, fungi and virus. Classify and characterize using different methods. Formulate enzymatic relationships using kinetics. Apply the knowledge of using microbes in pollution control activities. Review emerging microbial contaminants.

Content	Hours
Applied Environmental Chemistry Introduction Importance of Environmental Chemistry as applied to Environmental Engineering, types of reactions, acid/base, precipitation, reversible and irreversible reactions. Concepts of equivalent mass in relation to acids, bases, salts and oxidizing and reducing agents. Chemical equilibrium – redox and ionic equations. Modes of expression for molarity, normality, molality, ppm, etc.	07
Electrochemistry Electrolytes, types of conductance. Method of determining the specific conductance of water/wastewater and its correlation with dissolved salts. Electrode, types of electrodes, electrode potential, etc. Measurement of emf and	08

pH (using slam electrode) and their applications in Environmental Engineering, electrode potential, etc. Buffers and buffer index.	
Colloidal and Surface chemistry Colloids – Types, properties and environmental significance. Colloidal dispersions in water, air and emulsions. Theory of colloids – double layer theory, zeta potential, destabilization of colloids (Schulze – Hardy rule) as applied to coagulation process. Absorption and adsorption process, adsorption isotherms.	07
Water and wastewater analysis Acidity, alkalinity, and hardness. Color, Fluoridation and defluoridation – significance and determination. Chlorination – residual chlorine and break point chlorination. Biochemical oxygen demand (BOD) – dissolved oxygen (DO determination and environmental significance). Types and measurement of BOD. Rate of biochemical oxygen demand and theoretical oxygen demand. Chemical oxygen demand (COD) – determination and its application in wastewater treatment.	08
Instrumental methods of analysis Lambert’s and Beer’s law. Colorimetry – estimation of iron and manganese in water samples. Methods of determining the trace organic and inorganic contaminants using emission and absorption technique and ICP.	07
Applied Microbiology Microscopic flora and fauna and their importance in environmental protection, microorganisms of importance in air, water and soil environment. Microbial enumeration techniques. Microbial Metabolism : Metabolic activity, anabolism and catabolism, influencing parameters, microbial metabolism of toxic chemicals and trace organics, bio concentration and bio magnification.	10
Bacteria: Morphology, spore formation, typical bacterial growth curve, Nutritional requirements, Growth Models specific growth rate and generation time, numerical problems. Algae: Occurrence, morphology, classification and environmental applications	07
Fungi: Classification, characteristics and environmental applications Virus: Types, characteristics and enumeration methods. Enzymes : Classification, kinetics of enzymatic reactions, Michaelis - Menton equation, factors influencing enzyme reactions, problems.	07
Recent trends - Use of microbial consortia in water and wastewater treatment, Emerging Microbial Contaminants- chemical and antibiotic resistant microbes	04
Total	65

TEXT BOOKS

- McKinney R.E. “Microbiology for Sanitary Engineers”, McGraw Hill.
- Pelzer, Chan and Ried (1998), “Microbiology”, Tata McGraw Hill Publishers
- Sawyer C.N. and McCarty, P.L., (2003), “Chemistry for Environmental Engineering and Science”, 5th Edition, TATA McGraw Hill Publishing Co. Ltd., New Delhi.

REFERENCES

- Gaudy and Gaudy (1980), “Microbiology for Environmental Scientists and Engineers”, McGraw Hill.
- Mall C.A.S & Day J.W., “Ecosystem Modelling in Theory and Practice: An Introduction with Case Histories”, John Wiley Publications
- APHA, (2002), “Standard Methods for Examination of Water and Wastewater”; 21st Edition.
- Chakraborty P, (2005), “Textbook of Microbiology”, 2nd Edition, New Central Book Agency Pvt. Ltd.,

PHYSICO-CHEMICAL PROCESSES FOR WATER TREATMENT

EVE 120

Credits – L:T:P – 3:2:0

CIE: 50 Marks

Hours/week:3(L) + 2(T)

SEE: 100 Marks

Course Objective

The course emphasizes on unit operations and processes of Water treatment facilities and its design considerations. At the end of the course the students are will be able to:

CO1: Explain the inter-relationship between water quality parameters and plant sizing, hydraulics flow diagram. design intake structures.
CO2: Understand aeration, sedimentation, coagulation and flocculation processes. Apply settling equations. Tube settlers and pulsators.
CO3: Evaluate performance of filter units along with filter backwash and to know the kinetics of disinfection.
CO4: knowledge about various miscellaneous treatment processes such as softening, fluoridation/ defluoridation and know the importance of removal of trace organics.
CO5: Relate generation of chemical sludge and its management. Describe the norms and different rural water supply schemes. Explain need for industrial water quality requirements.

Content	Hours
Basic Considerations – Water – (Surface & Ground) quality characteristics, Drinking Water Quality Standards, guidelines, inter-relationship between water quality parameters. Plant sizing and layout, Hydraulic profile. Pressure conduits - Rising main. Water distribution systems Water Supply Appurtenances- Valves, Fittings and Hydrants, Pumps and Pumping station - design considerations.	10
Water Treatment Facilities: Intakes – types & design considerations, Screening – design considerations. Aeration, Parshall flume, Sedimentation tanks– Principle, types of settling tanks, settling velocity Laws (Stoke’s, Transition law & Newton’s law); - Design Considerations & Numerical Problems.	12
Coagulation and Flocculation – Principle, Theory, types of coagulants and their best pH range, design Considerations and Numerical Problems Tube/plate settlers and pulsators.	07
Filtration – Principle, Mechanism, types, Design Considerations and Numerical Problems	07
Disinfection – Principle, Theory, kinetics of Disinfection, disinfection methods, influencing factors; Numerical Problems Disinfection byproducts and control.	07
Miscellaneous Water Treatment Facility: Water Softening Process – Principle, Theory, Types and Numerical Problems Removal of Iron and Manganese; Fluoridation and defluoridation Removal of specific/trace organic contaminants, removal of microplastics from water	12
Water Treatment Plant Residuals – Collection, Conveyance, Treatment and Disposal 5 R Technologies –reduce, reuse, recycle, reclaim and recovery,	10

Industrial Water treatment & Supply - Quality aspects of industrial water rural water treatment & supplies – norms and schemes	
Total	65

TEXT BOOKS

- Weber W.J., (1975) “Physico - Chemical Processes for Water Quality Control”.
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), “Environmental Engineering” McGraw Hill.
- Santhosh Kumar Garg, “Water Supply Engineering”, Khanna Publishers (Recent Edition).
- B. S. N. Raju, “Water Supply and Wastewater Engineering”

REFERENCES

- AWWA, (1971), “Water Quality and Treatment McGraw Hill.
- CPHEEO Manual, (1991), “Water Supply and Treatment”, GOI Publications.
- Fair, G.M., Geyer J.C and Okun, (1969) “Water and Wastewater Engineering” Vol II, John Wiley Publications.
- APHA, 2005, Standard methods for examination of water and wastewater, 21st Edition.
- Design data handbook by IWWA

DESIGN OF WASTEWATER TREATMENT SYSTEMS

EVE 130
Hours/week:3(L) +2(T)

Credits–L:T:P– 3:2:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course emphasizes on design criteria, design equations, kinetics, hydraulic diagrams for the design of unit operations and processes for wastewater treatment systems. It also deals with biological sludge handling and treatment. Discusses the importance of rural sanitation systems and natural and constructed wetlands.

At the end of the course the students will be able to:

CO1: Explain the need for wastewater treatment, categorize the wastewater based on characteristics, illustrate reactor types in wastewater treatment; explain the basic concept of mass balance; plan the treatment scheme through flow diagram, sewer design and hydraulic profile.
CO2: Understand and apply the design principles and criteria in designing units such as screen, grit chamber, primary settling tank. Establish biokinetic constants in the engineering design of wastewater treatment processes.
CO3: Describe the design criteria and design the suspended and attached growth biological wastewater treatment systems like activated sludge process, trickling filter, UASB, RBC
CO4: Emphasize the need for sludge separation, thickening and volume reduction. Design the facilities for biological sludge handling and treatment of biological sludge.
CO5: Illustrate wastewater treatment systems for rural areas. Explain the applicability of natural systems for treatment of wastewater.

Content	Hours
Domestic Wastewater characteristics, flow fluctuations, types of reactors and mass balance approach. Wastewater Treatment: Flow Diagrams and Hydraulic Profile. Design of Sewers: Design of sanitary sewer; partial flow in sewers, economics of sewer design; sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.	10
Kinetics of biological wastewater treatment systems – biokinetic constants and their determination, batch and continuous system. Design principles and design of unit operation systems - screen, equalization basin, grit chamber, primary settling tank.	12
Design Criteria and design of unit processes – suspended and attached growth systems, conventional activated sludge process and its modifications. Design principles of trickling filter, bio-towers and rotating biological contactors. Biological Sludge separation , conditioning and volume reduction, toxicity assays Tertiary treatment: MBR, ZLD, SBR, MBBR	15
Design of Sludge Processing units – secondary settling tank, sludge thickeners and digesters– aerobic and anaerobic.	08
Wastewater treatment systems for small communities – septic tanks, soak pits, two-pit latrines, eco-toilet. Natural and constructed wetlands.	8
Nano materials for pollution control, Use of computer software in sewer networks.	12
Total	65

TEXT BOOKS

- Karia G.L., and Christian R.A., (2001), "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.
- Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4thEdition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Wastewater Treatment Plants Planning Design And Operation by Syed R Qasim, 1998

REFERENCES

- Benefield R.D., and Randal C.W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.
- Ronand L., and Droste, (1997),"Theory and Practice of Water and Wastewater Treatment", John Wiley and Sons Inc.
- "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Gol, New Delhi, 2003.
- M.J.Hammer, "Water and Wastewater Technology", Regents / Prentice Hall, New Jercy, 2001.

PHYSICO-CHEMICAL TREATMENT PROCESSES LAB

EVE 170

Credits – L:T:P = 0:0:1.5

CIE: 50 Marks

Hours/week: 3 Hrs/week

Course Objective

The lab course provides an opportunity to collect and preserve water samples from different sources, conduct various tests on water quality parameters, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining coagulant dose, efficiency of settling basin, rate of adsorption and life of adsorbent. The lab course also exposes the student to various advanced instruments used in analysing toxic chemicals and trace organics in water and wastewater.

At the end of the course the students will be able to:

CO1: Acquaint with precision and accuracy of analytical data and to appreciate rounding off to a significant value in the context of water quality parameters. Apply various methods of sample preservation and conduct titrimetric and instrumental analyses on water samples
CO2: Carryout and determine treatment efficiency of various water treatment processes – aeration, jar test for optimum dose of coagulant and settling experiments, adsorption experiments with isotherms and break through curve
CO3: Plan and perform filtration experiments, understand the significance of break point chlorination and plot particle size distribution curve, determine Uniformity coefficient. Develop the skill of analysing, interpreting and inferring the laboratory data

Experiment	Hours
Titrimetric and Instrumental Analyses of Water Quality Parameters – Ground and Tap Water Samples	06
Determination of Chlorine Demand for a given water sample and to plot the Break Point Chlorination Curve	06
Determination of Optimum Coagulant Dose using Jar Test Apparatus for given water samples	06
Conducting Settling Experiments and identify Type 1 and Type 2 settling and the determination of settling efficiency	03
Performing Sieve Analysis for Filter Sand samples	06
Carrying out experiments on Single and Multimedia Filters and Head Loss calculation	06
Conducting Adsorption Experiments using Activated Carbon and plotting of Isotherms and Breakthrough Curve	06
Demonstration of Advanced Instruments such as ICP, UV-VIS Spectrophotometer, HPLC	03
Total	42

REFERENCES

- American Public Health Association, American Water Works Association, (1998), Standard Methods for Examination of Water and Wastewater, 20th edition, APHA.
- NEERI, Nagpur, “Water Quality Analysis Manual”.
- Bureau of Indian Standards (BIS) Codes

ADVANCED COMPUTATIONAL METHODS AND OPTIMIZATION

(ELECTIVE I)

EVE 141

Credits – L:T:P = 4:1:0

CIE: 50 Marks

Hours/week: 4(L) + 1(T)

SEE: 100 Marks

Course Objective

The course introduces both numerical methods and analysis along with optimization and statistics. The student will be gaining knowledge of partial differential equations, their analytical solutions. Optimization deals with both problems with constraints and without constraints. The course lays the base for statistical methods and their applications for environmental data analysis and interpretation.

At the end of the course the students will be able to:

CO1: Analyse the partial differential equations using Newton-Raphson and Finite Element methods and arrive at solutions.
CO2: Apply explicit and implicit methods to solve simple parabolic problems
CO3: Classify, analyse and solve simple to complex optimization problems with and without constraints.
CO4: Apply numerical search method for both linear and non-linear problems. Use interpolation methods for environmental data analysis and interpretation.
CO5: Describe and apply concepts of probability, central tendency and distribution. methods to characterize or analyse the environmental data. Formulate null hypothesis and apply regression analysis for a given set of data.

Content	Hours
Numerical Methods Newton – Raphson method for solution of simultaneous equations, Numerical solutions of partial differential equations, finite difference, finite element method, explicit and implicit methods to solve simple parabolic differential equations.	20
Optimization Classification of optimization problems. Importance in Environmental Studies. Single and multivariable optimization without and with constraints. Linear programming – standard form of problems – pivotal reduction of equations. Single and two-phase simplex methods. Numerical search methods for I – D, non-linear problems-Dichotomous. Fibonacci and Golden section methods. Quadratic and cubic interpolation methods. Solutions of linear programming problems.	25
Statistics and Probability Frequency Distribution – Characteristics of Distributions: Central tendency and dispersion. Concepts of Probability – Binomial, Poisson and Normal distribution – applications, methods of least square and regression, multiple regression, Chi-squared	20

test, F test, t-test. Analysis of Variance – Tolerance and control charts. Solutions of regression analysis problems.	
Total	65

TEXT BOOKS

- Rao, S.S., (1996), “Optimization: Theory and applications” - Wiley Eastern Ltd. Publications
- Shanthakumar M., (1987), “Computer Based Numerical Analysis”, Khanna Publishers
- Levin R I., (2008), “Statistics for Management”, Pearson Education India

REFERENCES

- Anthony Ralston, and Philip Rabinowitz, (2001), “A First Course in Numerical Analysis” - Second Edition, Published by Dover Publications
- Desai, C.S., and John F Abel, (1972), “Introduction to the Finite Element Method: Numerical Method for Engineering Analysis” -Van Nostrand Reinhold, New York
- Taha, H.A., (2008), “Operations Research – An Introduction, 8th edition, Pearson Education India

SOLID WASTE ENGINEERING AND MANAGEMENT

EVE142

Credits–L:T:P=4:1:0

CIE:50Marks

Hours/week:4(L) +1(T)

SEE: 100Marks

Course Objective

The student will have a thorough understanding of key functional elements in municipal solid waste management including waste minimization concepts. And also designing of engineered land fill sites for the disposal of wastes.

At the end of the course the students will be able to:

CO1: Identify improper practices of solid waste disposal and their environmental implications. Know the basic engineering principles of solid waste management
CO2: Describe the need for economics in collection and transportation of solid waste and clearly discuss various types of collection systems and analyse system dynamics
CO3: Understand the management concepts, define 4R approach, apply PPP model and community involvement for effective management of solid waste
CO4: Develop a concise idea on various conventional and advanced treatment options for solid waste
CO5: Conceive the design aspects of engineered disposal options and apply the gained knowledge to solve numerical examples.

Content	Hours
Introduction Sources of solid waste, engineering classification, characterization, quantification; functional elements of solid waste management system– Environmental implications of open dumping, Construction debris – management & handling.	06
Waste Generation: Rate of generation, frequency, storage and refuse collection, Physical and chemical composition, quantity of waste, engineering properties of waste.	07
Collection, Segregation and Transport: Handling and segregation of wastes at source, Collection (primary & secondary) and storage of municipal solid wastes, collection Equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics,	08
Waste Minimization: 4R: reduce, recover, recycle and reuse, case study, guidelines	04
Treatment Methods: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: Composting, vermin composting, vermin gradation, fermentation. Incineration and Pyrolysis of solid wastes.	09
Disposal Methods: Impacts of open dumping, site investigation and selection, sanitary Land filling-Types, geotechnical considerations, design criteria and design, Liners-earthen, geo membrane, geo synthetics and geo textiles.	07

Operational aspects of MSW Landfills: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems–Design, leachate treatment. Landfill post-closure environmental monitoring; land fill remediation.	09
E- Waste Management, Bio-medical waste management.	03
Recent Developments in Solid Wastes Reuse and Disposal: Power Generation, Blending with construction materials and Best Management Practices (BMP). Community based waste management, Waste as a Resource concept, Public private Partnership (PPP)	07
Role of various organizations in Solid Waste Management: Governmental, Non - Governmental, Citizen Forums	02
Total	65

TEXTBOOKS

- Tchobanoglous G.,Theissen H., and EliassenR., “Solid Waste Engineering Principles and Management Issues”, Mc Graw Hill, NewYork.
- Pavoni J.L.,“Hand book of Solid Waste Disposal”.
- Peavy, Rowe and Tchobanoglous, “Environmental Engineering”,McGrawHill.
- Mantell C.L., (1975), “Solid Waste Management”,JohnWiley.

REFERENCES

- CPHEEO Manual on Solid Waste Management.
- WHO Manual on Solid Waste Management.
- Vesiland A., “Solid Waste Engineering”, Thompson Books.
- Flintoff F.,(1976),“Management of Solid Wastes in Developing Countries”, WHO Regional Publications, South East Asia, NewDelhi

**ECOLOGY AND ENVIRONMENTAL STATISTICS
(ELECTIVE I)**

EVE 143

Credits – L:T:P = 4:1:0

CIE: 50 Marks

Hours/week: 4(L) + 1(L)

SEE: 100 Marks

Course Objective

The course introduces both ecology and statistics for environmental engineers. It explains different ecosystems and their interactions through symbiotic and synergic relationships, reviews ecological indices and modes. It describes trophic levels of lakes, influence of nutrient loading and control measures for eutrophication. The course also provides an in depth knowledge of basic statistics, statistical methods used for data processing, analysis and interpretation. It describes distribution methods, variance, correlation and regression and testing of hypotheses.

At the end of the course the students will be able to:

CO1: Classify and discuss the structure and function of ecosystems. Describe symbiotic and synergic relationships. Illustrate the need for bio- geo- cycles. Apply ecosystem models.
CO2: Classify ecosystems. Calculate Dominance and Diversity Indices and describe factors influencing aquatic ecosystem. List and differentiate trophic status of lakes. Calculate nutrient loading and apply Leibig’s law.
CO3: Discuss the need for statistical methods for environmental data processing and analysis. Describe and perform frequency analysis and grouping of data.
CO4: Review basic statistical data analysis and probability concepts. Distinguish between normal, Poisson’s and binomial distribution. Solve numerical examples
CO5: Describe correlation and regression methods of data analysis. Estimate the regression coefficient using different methods. Solve numerical problems. Perform different methods of null hypotheses on a given set of data. Solve numerical examples to understand different methods of null hypotheses.

Content	Hours
Ecology: Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Biogeochemical cycles, Ecological Pyramids. System ecology and Ecosystem Modeling Aquatic and Terrestrial Ecosystems: Diversity and dominance Indices, Ecosystem Models.	08
Lake Ecosystem: Trophic levels, nutrient loading, nutrient enrichment, Leibig’s Law, control of eutrophication.	03
Applied Statistics Introduction; Sample and Population; Discrete and Continuous; Subdivisions – Descriptive, Inferential and Decision Theory; Collection, Arranging and Presentation of data; Frequency grouping; Frequency and relative frequency distribution;	08

Cumulative frequency; Surge's rule; Frequency polygon; Ogives; Problems.	
Characteristics of Distributions: Central Tendency – Averages: Arithmetic mean (Ungrouped data & Grouped data); Median (Ungrouped data & Grouped data); Mode (Ungrouped data & Grouped data); Skewness; Geometric mean; Weighted mean; Moving averages – equations to river hydraulics; Problems.	09
Probability: Basic concepts; Types – Classical approach, Relative frequency approach, Subjective approach; Probability rules; Problems.	09
Probability Distributions: Binomial distribution – derivation; Poisson distribution – derivation; Normal distribution – errors, Gauss function, Area under normal curve, Use of standard normal probability distribution table; Problems.	08
Correlation and Regression Analysis: Scatter Diagrams; Correlation coefficient; Multiple correlation coefficient; Simple linear regression; Multiple regression equation; Estimation using regression line; Method of Least Squares; Standard error of estimate; Problems.	10
Testing Hypotheses: Concepts basics; Null hypothesis; Level of Significance; Degrees of Freedom; Hypothesis testing of Means; The Chi-Squared test; F distribution; Students t test; Analysis of Variance – within samples and between samples; Problems	10
Total	65

TEXT BOOKS

- Odum E.P. & Barret G.W., (2005), “Fundamentals of Ecology”, 5th Edition , Cengage Learning
- Adam M. Neville and John B. Kennedy, “Basic Statistical Methods for Engineers and Scientists”, International Text Book Company.
- Richard I. Levin and David S. Rubin, “Statistics for Management”, Prentice Hall of India Pvt. Ltd., New Delhi.

REFERENCES

- George E. P. Box, William G. Hunter, and J. Stuart Hunter, “Statistics for Experiments an Introduction to Design, Data Analysis, and Model Building”, John Wiley & Sons.
- APHA, (2002), “Standard Methods for Examination of Water and Wastewater”; 21st Edition.

**RISK ASSESSMENT AND HAZARDOUS WASTES MANAGEMENT
(ELECTIVE II)**

EVE 151

CREDITS – L:T:P = 4:1:0

CIE: 50 Marks

Hours/Week: 4(L) + 1(T)

SEE: 100 Marks

Course Objective

The course deals with sufficient knowledge on need and principles of risk assessment methodologies and tools. Hazardous waste management techniques are also covered. Provides detailed design aspects of the treatment, disposal and analytical methods of hazardous wastes.

At the end of the course the students will be able to:

CO1: Define terminologies; Explain risk assessment models and tools. Perform the process of risk assessment and illustrate exposure assessment models. List hazard identification methods.
CO2: Describe release assessment models and monitoring methodologies including statistical models. Apply various testing methods for exposure assessment in different environmental systems and human exposure models.
CO3: Review of case studies with respect to risk identification, assessment and emergency preparedness. Identify the sources and describe characteristics of hazardous wastes. Enumerate on waste minimization and resource recovery techniques
CO4: Prepare the transportation protocol for safe transport of hazardous wastes. Propose and design the treatment methods including Engineered land fill and containment.
CO5: Describe in-situ and ex-situ bioremediation processes for contaminated soil.

Content	Hours
Risk Assessment Risk – Importance, Identification, characterization, communication – Internal & External, Risk - Management Structure, management Cycle, Participation and Consultation Ecological Health impact assessment. Exposure assessment. Risk factors. Sorption/partitioning of organics, volatilization and structural / property activity relation.	07
Risk factor calculation, impact identification – Risk Area, impact, Likelihood, consequences, Controls, Severity, risk score calculation; Toxicology and Risk Assessment: Toxic effects, Dose response assessment, Risk exposure assessment, Carcinogenesis, ecotoxicology, risk characterization.	08
Hazard identification and Risk Assessment – HAZOP, HAZID, Risk Ranking Matrix, Process and Instrumentation Diagram, and importance of Standard operating procedures, Material safety and Data Sheets, Guidelines, case study	08
Emergency Preparedness , Incident Investigation, Non Conformity, action and Preventive and Corrective Actions, Auditing.	06

Hazardous Waste Management Sources, Classification, Impacts of Mismanagement, Problems in Developing Countries, and Regulations for Hazardous Waste Management	08
Hazardous Waste Characterization , Designated Hazardous Wastes, Waste Minimization and Resource Recovery – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.	07
Transportation of Hazardous Waste – requirements, regulations, containers and Labeling, bulk and non-bulk transport, Emergency Response, personal protective equipment.	06
Treatment & Disposal: Physico-chemical, Chemical and Biological Treatment of hazardous waste, Thermal treatment - Incineration and pyrolysis	05
Landfill – Site selection, design approach, liner and leachate and gaseous collection systems. Cover system, Contaminant transport through landfill barriers, landfill stability, closure and post closure care, other types of disposal facilities, Design Criteria and Examples. Facility Siting and Process Selection for treatment, storage, disposal facility (TSDF). In situ and Ex situ bioremediation of contaminated soils. Software mini tab	10
Total	65

TEXT BOOKS

- Lagrega M.D., Buckingham P.L., and Evans J.C., (1994), “Hazardous waste Management”, McGraw Hill International Edition
- Wentz C.A., (1995), “Hazardous Waste Management”, McGraw Hill International Edition

REFERENCES

- Sincero A.P., and Sincero G.A., (1996),” Environmental Engineering- A Design Approach”, Eastern Economy Edition, Prentice Hall of India Pvt., Ltd.
- Lehman, (1983), “Hazardous Waste Disposal”, Plenum Press.
- Fawcett, (1984), “Hazardous and Toxic Materials: Safe Handling and Disposal”, John Wiley.
- CPCB guidelines for Hazardous Wastes

**NATURAL RESOURCES' CONSERVATION AND MANAGEMENT
(ELECTIVE II)**

EVE 152
Hours/Week: 4(L) + 1(T)

Credits – L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course describes natural resources and their significance for life existence with an emphasis on Sustainable Development. It deliberates in depth on the various conservation techniques to be adopted. The course also enriches the student with possible legislative measures and management options for effective and efficient management of available natural resources for human consumption and societal development.

At the end of the course the students will be able to:

CO1: Introduce the concept of sustainable development. Discuss the role of Environmental Engineers in sustainable development and conservation of natural resources
CO2: Differentiate between biotic and abiotic, renewable and non – renewable resources of nature. Describe the flow of resources and resource use problems
CO3: Describe the importance of forest, water and mineral resources, their deterioration and effective conservation and management practices.
CO4: Explain the significance of food, energy and land resources and identify the possible pollution sources and their effective management to conserve these resources.
CO5: Apply the knowledge of legal frame work and management concepts through host of acts and regulations for natural resources conservation and management.

Content	Hours
Introduction to Sustainable Development Need, importance and role of Environmental Engineers	07
Renewable and Non-renewable Resources Resources - Appraisal, problem, classes, renewable resources flow, destruction versus conservation	07
Forest Resources Ecological and economic significance, types and management, forest resources of the world and India, deforestation and its impact and solution	07
Water Resources Worldwide supply, renewal and distribution, water resources of India, Managing water resources, Environmental Impact of large dams, River water disputes, water pollution problems	07
Mineral Resources Sources, exhaustibility, Exploration and uses, Environmental impacts and solutions	04

Food Resources World food production and problems, agri production, live stock production, modern agri practices, use of pesticides and fertilizers – environmental impact, environmental limits of increasing food production, sustainable agriculture	08
Energy Resources Energy resources, world energy demand, Indian resources, renewable, alternate / non-conventional energy resources – solar, tidal, wind, geothermal, hydel, hydrogen, biomass , nuclear, wave (ocean)	08
Land Resources Land as a resource, soil – types and degradation, soil conservation	08
Biodiversity Resources Genetic and species diversity, Ecosystem diversity & major ecosystems, importance of biodiversity, value of biodiversity, hot-spots of biodiversity, threats to biodiversity, conservation of biodiversity	08
Environmental Legislation for resource management Legal frame work, organizations and institutions, acts promulgated by India – Wild Life Act, Biodiversity Conservation Act, Environmental (Protection) Act, Forest Act	08
Total	65

TEXT BOOKS

- Anjaneyulu Y., (2004), “Introduction to Environmental Science”, B.S. Publications, Hyderabad
- Misra S.P. and Pandey S.N., (2008), “Essential Environmental Studies”, Ane Book Publishers, New Delhi

**ENVIRONMENTAL HEALTH AND OCCUPATIONAL SAFETY
(ELECTIVE II)**

EVE 153
Hours/Week: 4(L) + 1(T)

Credits – L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

This course enables student to learn the basic principles of safety, OSH act and the national policy. It instills knowledge on cause - effect relationships of accidents at work places, need for ergonomics & ergonomics, hazard identification and control aspects, fire prevention and control. Work place health related issues are also covered.

At the end of the course the students will be able to:

CO1: Gain knowledge on safety principles, right-to-know laws and manages situation applying theories of accident at workplace. Perform accident investigation and report preparation
CO2: Develop skill of understanding the ergonomics and address specific problems with appropriate strategies. Identify the problems related to ergonomics and suggest remedial measures.
CO3: Identify, analyse the hazards using various techniques and prepare preventive plans. Also, understand the hazards in selected industries and suggest remedial measures for their control
CO4: Describe the need for product safety and its importance and acquire knowledge on various aspects of fire - types, prevention and protection
CO5: Discuss Health and Safety Considerations at different work places with a thorough understanding of PPEs. List different types of diseases and recommend health emergency mechanism. Gain knowledge through some best management practices.

Content	Hours
Occupational Hazard and control Principles of Safety, National Safety Policy. Occupational safety and Health Act (OSHA), Occupational Health and Safety administration - Laws governing OSHA and right to know.	08
Accident – causation, investigation, investigation plan, Methods of acquiring accident facts, Supervisory role in accident investigation, industrial safety – Man vs. Machine, Facts and fact finding – safety psychology and education. Monitoring, Report writing & mind map, Review and Audit.	08
Ergonomics at work place, Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, Ergonomic Programs. Risk assessment – Objectives, Needs and forms.	07
Hazard cognition and Analysis, Human Error Analysis – Fault Tree Analysis – Emergency Response - Decision for action – purpose and considerations, Engineering versus management control, Hazard control measures. Fire prevention and protection - Fire Triangle, Stages of Fire development, mode of heat transfer, Effect of Enclosures, early detection of Fire, Classification of fire and Fire	12

Extinguishers.	
Electrical Safety – Hazards associated and protective methods, Product safety – Technical Requirements of Product safety. Chemical Safety – Routes of entry, sources of information used to convey a chemical’s hazard, Safehandling of chemicals, safety procedures at Nuclear installations.	08
Health considerations at work place – types of diseases and their spread, Health Emergency, prevention.	06

Personal Protective Equipment (PPE) – types and advantages, effects of exposure and treatment for metal working trades, municipal solid wastes, foundries. Occupational Health and Safety considerations in water and wastewater treatment plants. Handling of chemical and safety measures in water and wastewater treatment plants and labs.	12
Total	65

TEXT BOOKS

- Goetsch D.L., (1999), “Occupational Safety and Health for Technologists, Engineers and Managers”, Prentice Hall.
- Heinrich H.W., (2007), “Industrial Accident Prevention - A Scientific Approach”, McGraw Book Co.

REFERENCES

- Colling D.A., (1990), “Industrial Safety Management and Technology”, Prentice Hall, New Delhi.
- Della D.E., and Giustina, (1996), “Safety and Environmental Management”, Van Nostrand Reinhold International Thomson Publishing Inc.
- Biomedical Waste (Handling and Management) Rules
- CPHEEO Manual on Water Supply and Sewage Treatment.
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), “Industrial Safety and Pollution Control Handbook”
- Trevethick, R.A., (1973), “Environmental and Industrial Health Hazards”- William Heinemann Medical Books Ltd., London

AIR QUALITY MODELING AND DESIGN OF AIR POLLUTION CONTROL TECHNIQUES

EVE210
Hours/Week: 3(L) +2(T)

Credits–L:T:P=3:2:0

CIE:50Marks
SEE: 100Marks

Course Objective

The course covers the air pollution sources, classification, effects, and measurement of air pollutants, standards, importance of meteorology in air pollutant dispersion, fate and transport of air pollutants using various mathematical tools, as well as air and noise pollution control technologies and regulations.

Student will be able to :

CO1: Understand the importance of composition and structure of atmosphere, sources, classification, effects of air pollutants, and measurement of air pollutants, air pollution standards and control regulations.
CO2: Understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants and to create wind rose diagram.
CO3: Gain Knowledge about the monitoring of particulate matter and carryout experiments on different monitoring tests for ambient air quality parameters.
CO4: Prediction of dispersion of air pollutants using different models and to evaluate the plume rise using various model equations and get a fair knowledge on stack sampling.
CO5: Understand and analyze the basic mechanisms involved, working principles and design aspects of various air pollution controlling equipment's through demonstration.

Content	Hours
Introduction : Composition and structure of the atmosphere; sources, characterization and classification of atmospheric pollutants, air pollution episodes. Effects of air pollutants on human health, vegetation, animals and materials and monuments. Visibility and other related atmospheric characteristics. Units and conversions.	09
Meteorology: Wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth, Ventilation coefficient, Temperature Inversions, plume behaviour, Wind rose diagram, general characteristics of stack emissions, heat island effect.	09
Monitoring of particulate matter: Respirable, non-respirable and nano - particulate matter. Monitoring of gaseous pollutants – CO, CO ₂ , Hydrocarbons, SO _x and NO _x , photochemical oxidants. Monitoring equipment and sampling devices – stack sampling (Isokinetic sampling), air samplers, gas exhaust analyzer. Air Pollution Index.	09
Pollutants' dispersion models: Point, line and areal sources models. Box model, Gaussian plume dispersion model – for point source (with and without reflection), Gaussian dispersion coefficient, Pasquill and Gifford atmospheric stability classification. ISCST3/ISCLT3 model, Determination of ground level concentrations. Infinite line source Gaussian model. plume rise and effective stack	10

height calculations and Air pollution pollutant and prediction Numerical Problems.	
Control Equipment for gaseous pollutants – adsorption, absorption, condensation and combustion. Design principles. Online emission monitoring system (DEMS), odor and VOCs	10
Air Pollution Control Equipment: Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP) - Design principles and design criteria.	07
Indoor Air Pollution : Sources, indoor air contaminants, effects and control. air changes per hour (ACH), IAQ Standards.	05
Lab Component <ul style="list-style-type: none"> • Monitoring of ambient air quality parameters using H.V.A.S. • Measurement of indoor air quality using microbial air sampler • Demonstration on Wind Monitoring and Analysis of Data for Wind rose Diagram • Vehicular emission test using auto exhaust analyzer for petrol and diesel vehicles. • Stack Sampling Techniques and Demonstration of Stack Monitoring. • Demonstration / Exercises on Air Pollution Control Devices - Bag Filter, Scrubber, Cyclone and ESP. 	06
Total	65

TEXT BOOKS

- Wark, K., Warner, C.F., and Davis, W.T., (1998), “Air Pollution”- Its Origin and Control”- Harper & Row Publishers, New York.
- Perkins, H.C ., (1980), “Air Pollution”, McGraw Hill.

REFERENCES

- Crawford, M., (1980),“ Air Pollution Control Theory”- TATA McGraw Hill.
- Stern, A.C., Air Pollution, Vol I, II, III.
- Stern, A. C., (1977), “Air Pollution : The Effects of Air Pollution” – 3rd- Edition, Academic Press
- Sincero, A.P. and Sincero, G.A. (1999), “Environmental Engineering - A Design Approach”, Prentice Hall of India, New Delhi.
- Kenneth Wark, Cecil F. Warn, “Air pollution its origin and control”, 2007.

ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

EVE 220
Hours/Week: 4(T) + 1(L)

Credits: L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course provides a detailed insight into the Indian environmental legislation aspects including National Environmental Policy, legal framework, Green Tribunal and various Acts related to environmental pollution, Prevention and control.

The course also deliberates on carrying capacity concepts, objectives, scope and types of impact assessment. Explains the process of impact assessment; and deals with various methodologies. Distinguishes between EMP and DMP. It reviews few case studies on EIA.

At the end of the course the students will be able to:

CO1: Explain the Constitution of India, National Environmental policy and Legal framework related to environmental aspects.
CO2: List and identify various Indian Environmental Acts in vogue, Amendments, modifications and notifications. Describe the Role of Green Tribunal.
CO3: Discuss the concept of Carrying Capacity; Environmental Impact Assessment studies for various developmental activities. Defines objectives, types and limitations of EIA. Lists and describes various EIA methodologies.
CO4: Describe the scope of EIA along with the framework. Propose the need for public participation in EIA. Explain importance of attributes, Standards and Value functions for various parameters. Apply predictive models.
CO5: Distinguish between EMP and DMP. Lists and explains Contents of EMP & DMP. Review important case studies.

Content	Hours
Environmental Legislation: Introduction & need, Constitution of India- Fundamental rights, duties, articles sections related to environmental protection, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (National Green Tribunal) Legal Framework, Legislative act, rules, regulations, notification and amendments.	10
Indian Environmental Acts: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972, Biodiversity Rules, 2004- Authorities, delegation, functions and penal procedures. ISO certification.	12
Environmental Impact Assessment: Carrying capacity concept, Evolution, Objectives, Types - Rapid and Comprehensive EIA, FONSI, NDS, EIS, Accreditation to EIA Consultants. Scope and contents of EIA, Step-by-step process in EIA & its Frame work, EIA process	10

limitations, TOR.	
Methodologies and techniques of EIA, Public participation in EIA.	06
Attributes – Air, water, land, noise, biotic, socio-economic - Standards and Value functions, Impact prediction models.	08
Environmental Audit, Environmental Management Plan (EMP) and Disaster Management Plan (DMP), onsite and offsite emergency plan, Environmental compliance	03
EIA Case Studies – Pharmaceutical, Thermal Power Plant, Mining, Construction Projects, Airports and Environmental Projects – Water and Wastewater Treatment Plants.	16
Total	65

TEXT BOOKS

- CPR Environmental Education Centre, (2006), Environmental Laws of India – An Introduction.
- Canter L., (1995), “Environmental Impact Assessment”, McGraw Hill.
- Jain R.K., Urban L.V., Stacey G.S., (1977), “Environmental Impact Analysis – A New Dimension in Decision Making”, Van Nostrand Reinhold Co. 12
- Clark B.C. Bisett and Tomlinsan P, (1985), “Perspective on Environmental Impact Assessment”, Allied Publishers.

REFERENCES

- Indian Acts related to Environmental Pollution Prevention and Control.
- Anjaneyulu and Valli Manickam, (2010), “Environmental Impact Assessment Methodologies”, BS Publications.

TRANSPORT PROCESSES AND MODELLING

EVE 230
Hours/Week: 3(L) + 2(T)

Credits: L:T:P = 3:2:0

CIE: 50 Marks
SEE: 50 Marks

Course Objective

The course emphasizes on various transport processes and illustration of mathematical models in simulation and prediction of pollutant concentration, and dispersion in surface and subsurface water bodies.

At the end of the course the students will be able to:

CO1: Know the simulation models for predicting fate and transport of pollutants with examples. Describe and differentiate the transport processes of advection and convection processes and derive related equations with analytical solutions.
CO2: Apply mathematical models and predict pollutant (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions; solve simple numerical problems.
CO3: Describe the concept of mixing zone in natural aquatic bodies and its influence on pollutant dispersion; prepare field monitoring protocol for measuring hydraulic as well water quality parameters.
CO4: Compare stratified and completely-mixed lake systems; describe mathematical equations to compute pollutant distribution in lake and estuarine systems. Design outfall system for ocean disposal.
CO5: Derive and apply 1-D groundwater model considering the influencing processes, field validation. Demonstrate the application of different prediction models for quality predictions and decision making.

Content	Hours
Modelling – Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick’s laws of diffusion, convective - diffusion equations for turbulent & shear flow regimes.	07
Steady-state water quality modeling - models for conservative and non-conservative substances. 1-D Oxygen balance models - Streeter-Phelps equation, critical point method. Calibration and verification of DO simulation model.	09
Mixing zones in rivers – types of outfalls and mixing regimes. Stream tube concept, Steady-state 2-D analysis. Parameter estimation - lateral mixing coefficient - critical point method, Case studies.	09
Data collection and analysis - specialized water quality surveys, estimation of decay and re-aeration rates.	07
Dissolved oxygen models for lakes under completely mixed and stratified conditions.	06
Estuaries – Salinity distribution, mathematical analysis of pollutant dispersion in estuaries. Ocean - disposal of wastewater - siting and design of outfalls.	09

Ground water quality modeling concepts - formulation of 1-D model with decay and retardation for instantaneous sources, plume delineation studies. Migration of pollutants through soil.	10
Salient features of environmental simulation models / software. Lab Component <ul style="list-style-type: none"> • River Water Quality Prediction Models – STREAM, QUAL2KW, MIXING ZONE Models • Data Analysis Models • IA 2D PIT • Prediction Models for estuary, lake and ocean using excel spreadsheet 	08
Total	65

TEXT BOOKS

- Thomann R.V., and Mueller J.A., (1987), “Principles of Water Quality Management and Control”, Harper & Row Publications.
- Schnoor J.L., (1996) “Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil”, John Wiley and Sons.

REFERENCES

- Rich L.G., “Environmental Systems Engineering “, McGraw Hill.
- Thomann R.V., (1980), “Systems Approach to Water Quality Management”, McGraw Hill.
- Lee C.C., and Lin S.D., (1999), “Handbook of Environmental Engineering Calculations”, McGraw Hill, New York.
- Metcalf and Eddy Inc., (1995), “Wastewater Engineering - Treatment and Reuse”, 3RD Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

BIOLOGICAL TREATMENT PROCESSES LAB

EVE 270

Credits – L:T:P = 0:0:1.5

CIE: 50 Marks

Hours/Week: 3 Hrs/Week

Course Objective

The lab course provides an opportunity to collect and preserve domestic wastewater samples as well as industrial effluents, conduct various tests on wastewater characteristics, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining bio kinetic constants for aerobic treatment process. The lab course also exposes the student to carryout analysis on biological sludge developed during the biological treatment of wastewater

At the end of the course the students will be able to:

CO1: Acquaint with the planning of domestic wastewater and industrial wastewater collection, transportation and preservation of samples. Perform standard tests for qualitative analysis and quantification of organic load. Conduct continuous CBOD and NBOD test.
CO2: Design and use the experimental set up to determine bio kinetic constants of biological waste treatment process. Characterize bio sludge through standard procedure to identify significant parameters.
CO3: Plan and perform aerobic and anaerobic bench scale treatment processes on both domestic wastewater and industrial effluent. Use constructed wetland (bench scale) system as polishing unit. Develop the skill of analysing, interpreting and inferring the laboratory data.

Content	Hours
Domestic and Industrial Wastewater analysis for different parameters	06
Determination of CBOD and NBOD of both domestic and industrial wastewater using BOD apparatus	06
Determination of Bio kinetic Constants - F/M , θ , θ_c , K_d , Y , q , μ	06
Analysis of Biological Sludge – MLSS, MLVSS, SVI	06
Aerobic process of treating domestic wastewater	06
Anaerobic process of treating domestic wastewater	06
Polishing unit – constructed wetland	06
Total	42

REFERENCES

- American Public Health Association, American Water Works Association, (1998), Standard Methods for Examination of Water and Wastewater, 20th edition, APHA.
- Adams and Eckenfelder Jr. W.W. (1974), “Environmental, Process Design Techniques for Industrial Waste Treatment”, Nashville (USA), 1974.
- Benefield, L.D., and Randall, C.W., (1980), “Biological Process Design for Wastewater Treatment”, Prentice Hall, Englewood, Cliffs, N.J.
- CPHEEO Manual (2014), “Wastewater Collection, Treatment and Disposal”, Ministry of Urban Development, Government of India, New Delhi.

- Metcalf and Eddy, (2003), “Wastewater Engineering, Treatment and Reuse”, 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITIES (ELECTIVE II)

EVE 241

Credits – L:T:P = 4:1:0

CIE: 50 Marks

Hours/Week: 4(L) + 1(T)

SEE: 100 Marks

Course Objective

The course encompasses the aspects of operation and maintenance of Environmental facilities. It highlights the operational problems and suggests the control, preventive and corrective measures.

At the end of the course the students will be able to:

CO1: Know the scope, types, basic principles, organizational structure, work planning and scheduling and cost estimates of O&M
CO2: Explain the importance of plans, drawing, map, record keeping. Recognize the need for operational manual and SOP. Discuss the advantages and limitations of SCADA based control systems
CO3: Identify and list the operational problems in water treatment and supply facilities. Apply preventive and corrective maintenance measures
CO4: Describe the operational problems in wastewater (Domestic and Industrial) collection and treatment facilities. Enumerate the remedial measures.
CO5: Identify and discuss the troubles in air pollution control systems and suggest the preventive and control measures

Content	Hours
Operation Maintenance & Management of Environmental Facilities Scope, Significance, Importance, Basic Principles, Objectives, Requirements, limitations. operation, maintenance and Management.	09
Organizational Structure, Work Planning, Preparation and Scheduling, Cost Estimates.	10
Data Base of Facilities Plan, Drawing, Map, Operation Manual, Record keeping, standard operating procedure	10
water Treatment and Supply Facilities – Operation, maintenance and management problems and their respective remedial and control measures of Different Units of water Treatment and Water Supply Facilities:	12
Wastewater Collection and Treatment Facilities: Operation, maintenance and management problems and their respective remedial and control measures of wastewater collection and treatment facilities	10
Industrial wastewater collection and treatment facilities: Operation, maintenance and management problems and their respective remedial and control measures of Industrial Wastewater collection and treatment facility.	10
Air Pollution Control Facilities: Operation, maintenance and management problems and their respective remedial and control measures of air pollution control facility.	12
Computer Applications in O&M and SCADA.	2
Total	65

TEXT BOOKS

- Hammer M.J., and Hammer Jr. M.J., (2008),” Water and Wastewater Technology”, Prentice Hall of India Pvt. Ltd., New Delhi.
- Metcalf and Eddy Inc., (2003), “Wastewater Engineering - Treatment and Reuse”, 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), “Environmental Engineering” McGraw Hill.
- Santhosh Kumar Garg, “Water Supply Engineering”, Khanna Publishers (Recent Edition).
- B. S. N. Raju, “Water Supply and Wastewater Engineering”

REFERENCES

- Training Manual on O&M for Municipal Staff, Asian Development Bank Project, Government of Karnataka.
- CPHEEO Manual, (1999) “Water Supply & Treatment”, GOI Publication.
- CPHEEO Manual., (1999) on Sewerage & Sewerage Treatment, GOI Publication.
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), “Industrial Safety and Pollution Control Handbook”

**DESIGN OF ADVANCED WASTEWATER TREATMENT PROCESSES
(ELECTIVE III)**

EVE 242

Credits – L:T:P = 4:1:0

CIE : 50 Marks

Hours/Week: 4(L) + 1(T)

SEE :100 Marks

Course Objective

The course covers in depth the advanced and hybrid wastewater treatment systems for the removal of nutrients, toxic organics, inorganic and trace contaminants, as well as sludge handling and disposal practices. It allows the student to understand design criteria and design the various advanced wastewater treatment processes.

At the end of the course the students will be able to:

CO1: Acquire knowledge of residual pollutants in the effluent of conventionally treated wastewater and their removal by various advanced processes
CO2: Describe different combinations of hybrid reactor systems and to design them for a given situation
CO3: Apply the knowledge of nutrients removal using advanced wastewater treatment processes design
CO4: Familiarize with the handling and disposal methods of both biological and chemical sludge from wastewater treatment facilities and comprehend the knowledge on recent advanced technologies. Apply design principles in designing the facilities
CO5: Discuss the need for application of environmental biotechnology for wastewater treatment. Differentiate in-situ and ex-situ bioremediation processes. Design Membrane bioreactors using design principles. Review the option of using wastewater for other purposes.

Content	Hours
Advanced Wastewater Treatment Systems: Residuals in treated wastewater and their removal, Gas Stripping, DAF, Advanced Oxidation, Electro dialysis, Ion Exchange & Adsorption, Micro and Ultra Filtration	15
Hybrid Wastewater Treatment Systems: Need for upgrading treatment plants, Possible Combinations of Physico chemical and Biological Processes. Electrochemical coagulation, UASB and Anaerobic filters, multistage anaerobic filters	10
Nutrients' Removal from Wastewaters: Nitrification and denitrification, physicochemical and biological phosphorus removal, SBR.	09
Sludge: Chemical Sludge – Sources and generation, types, characterization, recovery of metals, and alternate uses	10
Biological sludge – Sources and generation, characterization, utilization possibilities – compost	08
Recent Trends Environmental Biotechnology - genetically engineered microorganisms for wastewater treatment, bio remediation, bio sensors, membrane bio reactors (MBR), power generation from wastewater.	13
Total	65

TEXT BOOKS

- Metcalf & Eddy Inc, (2003), “Wastewater Engineering, Treatment and reuse”- 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Karia, G.L., and Christian, R.A., (2006) “Wastewater Treatment: Concepts And Design Approach ”– Prentice – Hall of India

REFERENCES

- Syed R. Qasim, (1999), “Wastewater treatment plants: planning, design, and operation” - 2nd edition, CRC Press LLC
- Moo-Young M., Anderson W.A., Chakrabarty A.M., (2007), “Environmental Biotechnology – Principles and Applications,” Kluwer Academic Publishers.

**GLOBAL WARMING AND CLIMATE CHANGE
(ELECTIVE III)**

EVE 243

Credits – L:T:P = 4:1:0

CIE : 50 Marks

Hours/Week: 4(L) + 1(T)

SEE : 100 Marks

Course Objective

The course emphasizes on the history of earth's climate, climate change, climate change impacts and vulnerability. It also covers the significant influence of anthropogenic and developmental activities on global warming and climate change. Several climate change models are also introduced. The student gains the knowledge of climate change mitigative measures, emission trading and its monitoring.

At the end of the course the students will be able to:

CO1: Review earth's climate change, identifies the causes for climate change. Introduces the climate change models and their application.
CO2: Describe impacts of climate change on various environmental compartments. Stresses the need for vulnerability assessment and its approach.
CO3: Explain the Indian scenario of climate change and its impact. Reviews various impact predictive models.
CO4: Define & describes emission trading, distinguishes different types of emission trading, understands the consequences of emission trading.
CO5: Highlight the need for emission trading, Describe emission trading mechanisms; suggest monitoring and enforcing agencies, their role and responsibilities in emission trading.

Content	Hours
Introduction: Global warming aggravations, Earth's climate, climate change, drivers of climate change, Kyoto, Montreal and New Delhi Protocols	07
Climate models: Models for climate change, GCMs, RCMs, climate change scenarios; Sector models – water resources, Agricultural, forestry, energy, GHG prediction models	08
Climate change impacts: Impacts of climate change on water sector, agriculture sector, infrastructure and energy systems with case studies	07
Vulnerability/adaptation: Need for vulnerability assessment; generic steps, approaches and tools of assessment; adaptation to climate change by various sectors	08
Mitigation: Mitigation measures for climate change, CDM and case studies	04
Climate change and India, impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India;	07
Emission trading Evolution of emission trading and design features, trading mechanisms Cost-effective permit markets, the role of transaction costs, the role of technical change, Consequences of emission trading	12
Monitoring and enforcement: domestic enforcement process, nature of international enforcement process, economic enforcement, current enforcement practice, program Effectiveness, global responsibilities for controlling climatic change	12
Total	65

TEXT BOOKS

- Shukla, P.R., et al. (2004), “Climate Change and India: Vulnerability Assessment and Adaptation” - Universities Press
- Konrad Soyez, and Hartmut Grabl, (2008), “Basic Facts, Evaluation and Technological Options” - Springer Publications

REFERENCES

- Thomas H. Tietenberg ,(2006), “Emissions trading: principles and practice” an REF Press book
- Noel D Nevers, (2000), “Air Pollution Control Engineering”, McGraw Hill International Editions, Civil Engineering Series, McGraw Hill
- Wark K., Warner C.F., and Davis W.T., (1997), “Air Pollution – Its Origin and Control”, Third Edition, Prentice Hall of India Publishers

**VULNERABILITY ASSESSMENT AND DISASTER MANAGEMENT
(ELECTIVE IV)**

EVE 251
Hours/Week: 4(L) + 1(T)

Credits-L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course imparts a thorough understanding of natural and manmade disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures. Stresses the role of modern engineering and information technology in disaster management. The course also supplements details on the legal framework along with few case studies.

At the end of the course the students will be able to:

CO1: State and classify disasters and identify the cause- effect relationships.
CO2: Apply the knowledge of vulnerability assessment for pre-planning, early warning systems and response plan. Prepare on-site and off-site ERPs.
CO3: Recognize the role of IT in creating vulnerability scenarios through simulation exercises using GIS and other related software and prepare Disaster and Environmental Management Plans
CO4: Consolidate the information on National policy on disaster management along with required legal framework for effective mitigation
CO5: Comprehend the lessons learnt from different natural and manmade disasters leading to newer initiatives for forecasting, planning and mitigation

Content	Hours
Introduction: Disasters, causes and impacts, scope of disaster management, disaster Managers- professionals and specialists active in various phases of disasters, Risk management, preparedness, operational functions of disaster management, Resource management, impact reduction.	10
Disasters: Natural disasters - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami; Manmade - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological (Bio-Terrorism) nuclear Disasters, accidental oil spills and other types of Disasters.	12
Vulnerability Assessment and Disaster Preparedness: Vulnerability assessment(VA). Importance and advantages, Process of VA, Steps in VA, Report, Prioritization, Emergency Response Plan (ERP).	08
Pre disaster Planning: Earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction. Coping mechanism and relief assistance, disaster management continuum, Early warning and management, Global Disaster alerting and coordination system (GDACS), Flood forecasting, flood control systems.	10
Disaster Response Planning, Preparedness and Mitigation: Earthquake, Cyclone, Landslide, Flood preparedness and response. NDMA act 2005, National Disaster Management Policy, Disaster Management Plans (DMP) , Guidelines.	10
Information Technology in Disaster Management: Application of GIS and Remote sensing for Disaster Management, Simulation studies. Use of Unmanned aerial vehicles (UAVs) in disaster management and monitoring.	10

Case studies: Natural, Industrial, Nuclear, Biological, Accidental Oil Spills, Recent case studies	05
Total	65

TEXT BOOKS

- National Research Council 2007. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11824>
- National Research Council 2007. Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11793>

REFERENCES

- Trim, P.R.J. (2004), "An integrative approach to disaster management and planning", Disaster Prevention and Management, Vol. 13 No. 3, pp. 218-225. <https://doi.org/10.1108/09653560410541812>
- National Research Council 2006. Facing Hazards and Disasters: Understanding Human Dimensions. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11671>
- National Research Council 2007. Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11895>.
- National Research Council 2006. The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness: Summary of the June 21, 2005 Workshop of the Disasters Roundtable. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11619>.
- WCDR Session Report UNEP, (2005), "Environmental Management and Disaster Preparedness" Building a multi-stakeholder partnership.

**NON-POINT SOURCES POLLUTION AND MANAGEMENT
(ELECTIVE IV)**

EVE 252
Hours/Week: 4(L) + 1(T)

Credits: L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course deals with importance, significance and types of non-point sources of pollution. It also covers mathematical simulation models for qualitative and quantitative assessment of non point source pollution and exposes to best management practices

At the end of the course the students will be able to:

CO1: Describe the problem and magnitude of non-point source pollution, relate with waste assimilative capacity of natural aquatic bodies and quantify the total load giving due consideration to components of hydrologic and atmospheric conditions
CO2: Explain source tracking and transport and fate of ground water pollution and assess influence of urbanization on pollution quantification and its movement
CO3: Apply available area and line source models for quantifying fugitive emissions from different air pollution sources
CO4: Understand of qualitative and quantitative aspects of non-point source pollution from agricultural and mining areas
CO5 : Apply the simulation models for pollution quantification and to evaluate the impacts of best management practices

Content	Hours
Introduction: Problem and magnitude, Surface Water Problems, Waste Assimilative Capacity and In-stream and Effluent Discharge standards.	08
Hydrologic Considerations: Introduction, Precipitation – Runoff Relationship. Overland Routing of the Precipitation excess, Interflow, Groundwater flow. Pollution from the Atmosphere – Atmospheric Input.	09
Groundwater Pollution: Sources of Groundwater Contamination, and Groundwater Movement.	08
Pollution from impervious urban areas: Urban storm water quantification, Deposition and accumulation of pollutants on impervious surfaces. Removal of Solids from street surfaces and porous pavement.	12
Pollution from agricultural and mining areas: Quantification and qualitative analysis.	08
Non-point Pollution Simulation Models: Basic Concepts, Brief Description of Non-point Pollution Simulation Models	08
Comparative Assessment of Pollution Impact from land uses, Land-use and non-point sources of pollution.	07
Best Management Practices of Non-point sources of pollution control.	05
Total	65

TEXT BOOKS

- Pavoni, J.L., “Water Quality Management Planning” Edited by Pavoni. J.L, (1997), Van Nostrand Reinhold Environmental Engg., Series
- Novotny, V., and Chester’s, G., (1981), “Hand Book of Non-point Pollution”, “Sources and Management” - Van Nostrand Reinhold Company.

**REMOTE SENSING AND GIS
(ELECTIVE IV)**

EVE 253
Hours/Week: 4(L) + 1(T)

Credits – L:T:P = 4:1:0

CIE: 50 Marks
SEE: 100 Marks

Course Objective

The course lays the foundation for basics of remote sensing, remote sensing systems, image processing, and related aspects. It also covers the various facets of GIS and data management as well as the applications of RS & GIS in Environmental Management

At the end of the course the students will be able to:

CO1: Describe the concepts and principles of remote sensing and remote sensing systems including EM spectrum, RS satellites and resolutions.
CO2: Interpret satellite images by applying the concepts of elements of visual image interpretation; explain the methodologies of image pre-processing, enhancement, filtering, transformation and classification; analyse the need for the application of these processing techniques.
CO3: Recognize the importance and need of GIS in environmental management; explain the concepts of co-ordinates and projection system and examine their relevance.
CO4: Differentiate between raster and vector data models and apply them to represent various geographic features, determine data input method, identify the errors and suggest methods of editing the data to remove the errors.
CO5: Perform raster and vector spatial analysis and design applications of remote sensing and GIS for various environmental issues including , watershed management, environmental monitoring, solid waste management, zoning atlas, ground water vulnerability, etc.

Content	Hours
Remote Sensing (RS) Basics of remote sensing: EMR spectrum; Energy sources and radiation laws, Energy interactions with atmosphere and Earth's surface features; Spectral reflectance curves, basic concepts of remote sensing, airborne and space borne sensors, passive and active remote sensing	08
Remote Sensing Systems: Ideal RS system, Platforms and orbits; Satellite system parameters, spectral bands of sensors; spectral, radiometric, spatial, and temporal resolutions of satellites; multi-spectral, thermal and hyper-spectral sensing; remote sensing satellites and their features	08
Image interpretation and processing: Visual image interpretation; concept of color, color composites, Preprocessing, image registration, image enhancement, spatial filtering, image transformation, image classification	08
Geographical Information System (GIS) Introduction: Origin and importance of GIS; scale; coordinate and projection systems, Linkage of Remote Sensing to GIS	07

Data Models and Structures: Spatial data models – Raster, vector; spatial and attribute data.	07
Spatial Data Input and Editing: Encoding methods of data input: keyboard, manual digitizing, scanning and automatic digitizing methods. Electronic data transfer, GPS, Data Editing: spatial and attribute data accuracy, concept of topology.	09
Spatial Analysis; Raster and Vector overlay analysis; Terrain modeling; Spatial interpolation; Buffering and Neighbourhood function, Networks;	08
Applications of RS and GIS: Pattern detection and characterization, pattern comparison, space-time emphasizing application, predictive modeling applications (Watershed management; Rainfall-runoff modeling; Flood mapping; Environmental monitoring; Groundwater vulnerability modeling; Optional routing of solid wastes collection system of an urban area; Environmental siting and zoning atlas development) Advanced topics: Microwave remote sensing	10
Total	65

TEXT BOOKS

- Lillesand, T. M., Kiefer, R. W., Chipman, J. W. (2004) “Remote sensing and Image Interpretation”, 5th Edition, John Wiley & Sons
- Michael N. DeMers (2008) “Fundamentals of GIS” John Wiley and Sons. Inc

REFERENCE BOOKS

- Anji Reddy (2008), “Text Book of Remote sensing and Geographical Information systems”, 3rd Edition, B. S. Publications, Hyderabad
- Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., (2005) Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, John Wiley & Sons, 2005.

Technical Seminar on Current Issues

EVE 160/260

CIE: 50 Marks

Course Objective: The technical seminar course provides an opportunity to search, understand and select an appropriate contemporary environmental issue, comprehend, infer, identify information gap and arrive at futuristic implications, prepare an abridged report and make multimedia presentation.

At the end of the course the students will be able to:

CO1: Identify and critically review the peer reviewed published documents on current environmental issues.
CO2: Develop creative thinking in identification of research gaps and to provide futuristic perspectives.
CO3: Develop written and multi-media presentation skills based on the literature reviewed.

- This technical seminar is applicable to both first and second semesters of the PG program.
- Students are assessed individually for their abilities on technical understanding, collection of relevant technical material, drawing inferences from published documents, oral and written presentation skills, etc.
- Each student is expected to give a technical seminar on topics related to current environmental issues with focus on research and field.
- Each student shall be under the supervision of a faculty member in the department who oversees the progress related to the technical seminar.
- Each student shall identify and collect relevant recent publications from peer reviewed, scopus indexed and web of science journals, technical reports and manuals. The students are expected to consult the respective guide and DPGC on finalizing the topic. They also are expected to appraise their guide on the progress made in report preparation and final presentation.
- Each student presents his/her chosen topic using multi-media presentation platform on the scheduled date and time, as decided by the Department Post-Graduate Committee (DPGC). The DPGC shall consist of three faculty members identified by HOD along with the HOD as Chairman.
- Each student shall submit the seminar report, approved by the guide, conforming to the standards and format decided by the department/DPGC.
- The course evaluation is based on the quality of technical material, technical understanding, comprehension, analytics, oral and written communication, time management and interactions.

Practical Training in Industry / Exploration Research

EVE 310T

Credits – L:T:P = 0:0:4

CIE: 100 Marks

Course Objective: The practical training course provides technical exposure for the students in the field of Environmental Engineering aspects and general administration as practiced in the industrial (goods and services) sector and other technical/scientific and research organizations. The training allows the students to understand, analyze, evaluate, comprehend, and critically think on the concepts learnt during their course curriculum, experience it practically and then write a technical report thus bridging the gap between classroom learning and practical implementation.

At the end of the course, the students will be able to:

CO1: Comprehend the organization structure and general administration, production/working process and environmental management in industries and organizations.
CO2: Critically observe and inculcate individual responsibility as well as team efforts to develop practical solutions towards sustainable development with innovative research and creative thinking.
CO3: Develop written and multi-media presentation skills for effective communication.

- Each student shall undergo industrial training for a duration of 8 weeks in the product/service sector industry or organization/company with an intention to gain exposure to technical reality beyond syllabus.
- The general areas of focus include Environmental Impact Assessment and Audit, Environmental Management Systems, Waste Management, Design-drawing-cost estimation of various environmental components, Operation and maintenance of environmental facilities, Performance evaluation of treatment systems for air and water attributes, Exposure to state-of-art instrumentation, automation and software, Environmental Health and Safety, etc.
- The dates for training are as per the calendar of events announced by the university after the completion of the semester end examination of the 2nd semester.
- Each student and/or by directions given by the faculty members will identify an industry/organization/company for training based on his/her merit and preference.
- During the training period, the student will learn work ethics, communication/managerial skills and application skills and collect useful information required for preparing the report and presentation.
- The industry authorities will be required to provide a comprehensive evaluation of the candidate in the specified format to the department.
- The student will report to the department at the end of the training period.
- The student will be required to prepare and submit a comprehensive report, to Department Post-Graduate Committee (DPGC) with due approval from the guide, on the work done and observation made during the industrial training. The DPGC shall consist of three faculty members identified by HOD along with the HOD as Chairman.
- The student is also required to make an interim presentation (after 4-5 weeks of training) and a final presentation using multi-media presentation platform on the scheduled date and time, as decided by the DPGC.
- The DPGC as well as the respective guide will jointly evaluate the performance of the student.
- The outcome of the internship will be in the form of generating ideas on water savings, energy savings, housekeeping practices and also bringing-in industry related problems to solve in the laboratory and giving feedback to the industries for improvements, following the ethical code of protecting the environmental attributes.

Dissertation work (Phase-I)

EVE 320P

Credits – L:T:P = 0:0:10

CIE: 100 Marks

Course Objective: The dissertation work trains the students to carry out literature review, identify the gaps/problems, devise workable objectives and methodology, conduct the investigation following engineering ethics, and analyze, interpret and present the findings and thus develop creative thinking, planning, time management, leadership qualities and managerial skills.

At the end of the course, the students will be able to:

CO1: Conduct systematic review of literature, identify research gaps, and define objectives and scope of work
CO2: Develop skills in terms of design, conduct investigations and data analytics
CO3: Develop oral and written communication skills for report preparation, paper publication and technical presentation

- Each student shall be associated with a faculty member serving as his/her guide to supervise the dissertation work.
- Periodic progress review presentations of the dissertation work shall be according to the calendar of events scheduled by the University.
- The student will work with the project guide/supervisor towards the identification of the problem through a systematic literature review and will finalize the objectives and scope of work.
- The student will present synopsis (review-1) and submit the same to the Department Post-Graduate Committee (DPGC) after due approval from the guide.
- The student will present the work progress as part of review-2 during the 1st phase of the project work.
- The DPGC and guide will jointly evaluate the student.

Dissertation work (Phase-I)

EVE 410P

Credits – L:T:P = 0:0:18

CIE: 100 Marks

SEE : 200 Marks

Course Objective: The dissertation work trains the students to carry out literature review, identify the gaps/problems, devise workable objectives and methodology, conduct the investigation following engineering ethics, and analyze, interpret and present the findings and thus develop creative thinking, planning, time management, leadership qualities and managerial skills.

At the end of the course, the students will be able to:

CO1: Conduct systematic review of literature, identify research gaps, and define objectives and scope of work
CO2: Develop skills in terms of design, conduct investigations and data analytics
CO3: Develop oral and written communication skills for report preparation, paper publication and technical presentation

- The student will continue with the 2nd phase of the intended project work as per the directives of the project supervisor.
- Periodic progress review presentations (review-3, review-4) of the dissertation work shall be according to the calendar of events scheduled by the University.
- The student will continue the work towards achieving the objectives of the intended dissertation work taking into consideration the suggestions given by the DPGC with the advice of the project supervisor.
- The student will make final presentation/ demonstration (review-5) of the dissertation work as per the calendar of events to the project evaluation committee.
- The student will prepare a comprehensive report of the dissertation work carried out conforming to the standards and format prescribed by the University and submit the same to the department after due approval from the guide.
- Prepare papers for presentation in seminars / conferences /symposium/workshops and technical paper publications in peer reviewed journals.
- The student will be required to present the dissertation work to a panel of examiners consisting of an external examiner from academia/industry of desirable cadre, supervisor and a member of DPGC on the date scheduled by the University.
- The evaluation of the dissertation work will be done at several levels by the DPGC members, supervisor as well as the external examiner as per the norms of the University.