APPLIED ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Subject Code: EVE 110 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 110 CO1: Name and distinguish a variety of chemical reactions and their importance. Review equilibrium chemistry and perform dimensional analysis. List and describe types of electrodes and electrode potential. Measure pH, emf and other related parameters.
EVE 110 CO2: Classify colloids, discuss their properties and their environmental significance. Reproduce the two-film theory and identify the salient features. Perform different analytical techniques for measuring water quality parameters and wastewater characteristics. Apply the knowledge of instrumental analytical techniques for measuring different types of environmental pollutants.
EVE 110 CO3: Discuss the need for microbiology and identify different flora and fauna of importance in water, air and soil media. Describe bacterial cell structure, function, microbial growth and metabolism. Apply various growth models and determine biokinetic coefficients.
EVE 110 CO4: Draw and identify bacterial cell structure and morphological features. Solve numerical problems on generation time, specific growth rate and decay rate. Analyze single & multiple substrate utilization rates.
EVE 110 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.

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.

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 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.

Water and wastewater analysis

Acidity, alkalinity, and hardness. 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.

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.

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, bioconcentration and biomagnification.

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

Fungi: Classification, characteristics and environmental applications

Virus: Types, characteristics and enumeration methods.

Enzymes : Classification, kinetics of enzymatic reactions, Michaelis - Menten equation, factors influencing enzyme reactions, problems.

Recent trends - Use of microbial consortia in water and wastewater treatment, Emerging Microbial Contaminants- chemical and antibiotic resistant microbes

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.
- Chakraborthy P,(2005), “Textbook of Microbiology”, 2nd Edition, New Central Book Agency Pvt. Ltd.,
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

PHYSICO-CHEMICAL PROCESSES FOR WATER TREATMENT

Subject Code: EVE 120 **CIE: 50**
No. of Credits: 3-2-0 = 5 **SEE: 100**

Course Objective

The course emphasizes on Design considerations of various unit operations and processes of Water treatment facilities.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 120 CO1: Explain the inter-relationship between water quality parameters and plant sizing, hydraulics and layout. Able to design intake structures.
EVE 120 CO2: Learn aeration, sedimentation, coagulation and flocculation processes. Able to explain settling equations. Tube settlers and pulsators.
EVE 120 CO3: Design filter units along with filter backwash system. Analyze chemistry of disinfection and to know the kinetics of disinfection. Understand adsorption process and apply the knowledge of isotherms.
EVE 120 CO4: Learn and design various miscellaneous treatment processes such as softening, fluoridation/ defluoridation. Able to know the importance and removal of trace organics.
EVE 120 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.

Design considerations – Plant sizing and layout, hydraulic flow diagram. Intake structures – types, design. Water quality characteristics and parameter interlinks. Inorganic and organic constituents.
Hydraulics of conduits - Rising main and water hammer analysis, pump design, water distribution systems.

Aeration – principles and design of aeration systems – two film theory. **Sedimentation** – types of settling and settling equations (Stoke's, Newton's, & Transition), design of settling tanks; Operational problems. Tube settlers and pulsators.

Coagulation and Flocculation – types of coagulants, coagulant aid, coagulation theory, optimum dose of coagulant, design criteria and design.

Filtration – theory, types, hydraulics of filter bed, design of filter units, filter backwash, operational problems and trouble shooting.

Disinfection - disinfectants, influencing factors, methods, byproducts and kinetics.

Adsorption – types, equilibrium kinetics and Isotherms and applications.

Miscellaneous treatment: Water Softening - Process operation and design. Fluoridation/defluoridation –design. Removal of specific/trace organic contaminants – Arsenic (As), natural organic matter (NOM), dissolved organic matter (DOM), Taste & Odor, Volatile organic compounds (VOCs), synthetic organic chemicals.

Residuals management at water treatment facility – solids production and characteristics, recovery of chemicals, minimization of residuals generation, sludge management and disposal.

Industrial and rural water supplies – Quality aspects of industrial waters, norms and schemes of RWS.

Laboratory Component

- Analysis of special water quality parameters using advanced instruments.
- To conduct settling experiments, coagulant dose using Jar Test, disinfection kinetics.
- Filter headloss and rate of backwash calculations.

TEXT BOOKS

- Fair, G.M., Geyer J.C and Okun, (1969) “Water and Waste water Engineering” Vol II, John Wiley Publications.
- Weber W.J., (1975) “Physico - Chemical Processes for Water Quality Control”.

REFERENCES

- AWWA, (1971), “Water Quality and Treatment McGraw Hill.
- CPHEEO Manual, (1991), “Water Supply and Treatment”, GOI Publications.
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), “Environmental Engineering” McGraw Hill.
- APHA, 2005, Standard methods for examination of water and wastewater, 21st Edition.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

DESIGN OF WASTEWATER TREATMENT SYSTEMS

Subject Code: EVE130 **CIE: 50**
Credits: 3-2-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE130 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 and hydraulic profile.
EVE130 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.
EVE130 CO3: Describe the design criteria and design the suspended and attached growth biological wastewater treatment systems like activated sludge process, trickling filter, UASB, RBC
EVE130 CO4: Emphasize the need for sludge separation, thickening and volume reduction. Design the facilities for biological sludge handling and treatment of biological sludge.
EVE130 CO5 Illustrate wastewater treatment systems for rural areas. Explain the applicability of natural systems for treatment of wastewater.

Domestic Wastewater characteristics, flow fluctuations, types of reactors and mass balance approach.

Wastewater Treatment Flow Diagrams and Hydraulic Profile.

Design principles and design of unit operation systems - screen, equalization basin, grit chamber, primary settling tank.

Kinetics of biological wastewater treatment systems – biokinetic constants and their determination, batch and continuous system.

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

Design of Sludge Processing units – secondary settling tank, sludge thickeners and digesters– aerobic and anaerobic.

Wastewater treatment systems for small communities – septic tanks, soak pits, two-pit latrines, eco-toilet. Natural and constructed wetlands,

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.

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

PHYSICO-CHEMICAL TREATMENT PROCESSES LAB

Subject Code: EVE 170 **CIE: 50**
Credits: 1.5

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 analyzing toxic chemicals and trace organics in water and wastewater.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 170 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
EVE 170 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
EVE 170 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 analyzing, interpreting and inferring the laboratory data

Experiments

- Titrimetric and Instrumental Analyses of Water Quality Parameters – Ground and Tap Water Samples
- Determination of Chlorine Demand for a given water sample and to plot the Break Point Chlorination Curve
- Determination of Optimum Coagulant Dose using Jar Test Apparatus for given water samples
- Conducting Settling Experiments and identify Type 1 and Type 2 settling and the determination of settling efficiency
- Performing Sieve Analysis for Filter Sand samples

- Carrying out experiments on Single and Multimedia Filters and Head Loss calculation
- Conducting Adsorption Experiments using Activated Carbon and plotting of Isotherms and Breakthrough Curve
- Demonstration of Advanced Instruments such as ICP, UV-VIS Spectrophotometer, HPLC

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
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

ADVANCED COMPUTATIONAL METHODS AND OPTIMIZATION (ELECTIVE I)

Subject Code: EVE 141 **CIE: 50**

Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVH 141 CO1: Analyze the partial differential equations using Newton-Raphson and Finite Element methods and arrive at solutions.
EVH 141 CO2: Apply explicit and implicit methods to solve simple parabolic problems
EVH 141 CO3: Classify, analyze and solve simple to complex optimization problems with and without constraints.
EVH 141 CO4: Apply numerical search method for both linear and non-linear problems. Use interpolation methods for environmental data analysis and interpretation.
EVH 141 CO5: Describe and apply concepts of probability, central tendency and distribution. methods to characterize or analyze the environmental data**.** Formulate null hypothesis and apply regression analysis for a given set of data.

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.

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.

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

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

SOLID WASTE ENGINEERING AND MANAGEMENT
(ELECTIVE I)

Subject Code: EVE 142 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 142 CO1: Identify improper practices of solid waste disposal and their environmental implications. Know the basic engineering principles of solid waste management
EVE 142 CO2: Describe the need for economics in collection and transportation of solid waste and clearly discuss various types of collection systems and analyze system dynamics
EVE 142 CO3: Understand the management concepts, define 4 R approach, apply PPP model and community involvement for effective management of solid waste
EVE 142 CO4: Develop a concise idea on various conventional and advanced treatment options for solid waste
EVE 142 CO5: Conceive the design aspects of engineered disposal options and apply the gained knowledge to solve numerical examples.

Introduction: Sources and engineering classification, characterization, generation and quantifcation; Objectives, principles, functional elements of solid waste management system – Regulatory aspects of solid waste management, major problems. Environmental implications of open dumping, Construction debris – management &handling, E- Waste Management, Rag pickers and their role.
Waste Generation: Rate of generation, frequency, storage and refuse collection, physical and chemical composition, quantity of waste, engineering properties of waste, prediction, modeling concepts.

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,

Waste Minimization: 4R: reduce, recover, recycle and reuse, case study, guidelines

Treatment Methods: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, vermigradation, fermentation. Incineration of solid wastes.

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.

Operational aspects of MSW Landfills: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems – Design, leachate treatment. Landfill Final Cap Design and Water Balance, Modelling (HELP – Hydraulic Evaluation of Landfill Performance), post-closure environmental monitoring; landfill remediation.

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)

Role of various organizations in Solid Waste Management: Governmental, Non - Governmental, Citizen Forums.

Laboratory Component

- Solid Waste Sampling
- Segregation, quantification and characterization
- Determination of Moisture content, calorific value, density,
- Leachate characteristics Analysis

TEXT BOOKS

- Tchobanoglous G., Theissen H., and Eliassen R., “Solid Waste Engineering Principles and Management Issues”, McGraw Hill, New York.
- Pavoni J.L., “Handbook of Solid Waste Disposal”.
- Peavy, Rowe and Tchobanoglous, “Environmental Engineering”, McGraw Hill.
- Mantell C.L., (1975), “Solid Waste Management”, John Wiley.

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, New Delhi
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials

ECOLOGY AND ENVIRONMENTAL STATISTICS
(ELECTIVE I)

Subject Code: EVE 143 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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, anlaysis and interpretation. It describes distribution methods, variance, correlation and regression and testing of hypotheses.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 143 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.
EVE 143 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.
EVE 143 CO3: Discuss the need for statistical methods for environmental data processing and analysis. Describe and perform frequency analysis and grouping of data.
EVE 143 CO4: Review basic statistical data analysis and probability concepts. Distinguish between normal, Poisson's and binomial distribution. Solve numerical examples
EVE 143 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.

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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.

Lake Ecosystem: Trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.

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; 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.

Probability: Basic concepts; Types – Classical approach, Relative frequency approach, Subjective approach; Probability rules; Problems.

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.

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.

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

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

RISK ASSESSMENT AND HAZARDOUS WASTES MANAGEMENT (ELECTIVE II)

Subject Code: EVE 151 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 151 CO1: Define terminologies; Explain risk assessment models and tools. Perform the process of risk assessment and illustrate exposure assessment models. List hazard identification methods.
EVE 151 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.
EVE 151 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
EVE 151 CO4: Prepare the transportation protocol for safe transport of hazardous wastes. Propose and design the treatment methods including Engineered land fill and containment.
EVE 151 CO5: Describe in-situ and ex-situ bioremediation processes for contaminated soil.

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.

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.

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

Emergency Preparedness, Incident Investigation, Non Conformity, action and Preventive and Corrective Actions, Auditing.

Hazardous Waste Management

Sources, Classification, Impacts of Mismanagement, Problems in Developing Countries, and Regulations for Hazardous Waste Management

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.

Transportation of Hazardous Waste – requirements, regulations, containers and Labeling, bulk and non-bulk transport, Emergency Response, personal protective equipment.

Treatment & Disposal: Physico-chemical, Chemical and Biological Treatment of hazardous waste, Thermal treatment - Incineration and pyrolysis

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

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

NATURAL RESOURCES' CONSERVATION AND MANAGEMENT (ELECTIVE II)

Subject Code: EVE 152 **CIE: 50**
Credis: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 152 CO1: Introduce the concept of sustainable development. Discuss the role of Environmental Engineers in sustainable development and conservation of natural resources
EVE152 CO2: Differentiate between biotic and abiotic, renewable and non – renewable resources of nature. Describe the flow of resources and resource use problems
EVE152 CO3: Describe the importance of forest, water and mineral resources, their deterioration and effective conservation and management practices.
EVE 152 CO4: Explain the significance of food, energy and land resources and identify the possible pollution sources and their effective management to conserve these resources.
EVE 152 CO5: Apply the knowledge of legal frame work and management concepts through host of acts and regulations for natural resources conservation and management.

Introduction to Sustainable Development
Need, importance and role of Environmental Engineers

Renewable and Non-renewable Resources
Resources - Appraisal, problem, classes, renewable resources flow, destruction versus conservation

Forest Resources
Ecological and economic significance, types and management, forest resources of the world and India, deforestation and its impact and solution

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

Mineral Resources
Sources, exhaustibility, Exploration and uses, Environmental impacts and solutions

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

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)

Land Resources
Land as a resource, soil – types and degradation, soil conservation

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

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

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

REFERENCES

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

ENVIRONMENTAL HEALTH AND OCCUPATIONAL SAFETY (ELECTIVE II)

Subject Code: EVE 153 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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 economics & ergonomics, hazard identification and control aspects, fire prevention and control. Work place health related issues are also covered.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 153 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
EVE 153 CO2: Develop skill of understanding the ergonomics and address specific problems with appropriate strategies. Identify the problems related to ergonomics and suggest remedial measures.
EVE 153 CO3: Identify, analyze the hazards using various techniques and prepare preventive plans. Also, understand the hazards in selected industries and suggest remedial measures for their control
EVE 153 CO4: Describe the need for product safety and its importance and acquire knowledge on various aspects of fire - types, prevention and protection
EVE 153 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.

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.

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.

Ergonomics at work place, Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, Ergonomic Programs.

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, Fire Development and its severity, Effect of Enclosures, early detection of Fire, Classification of fire and Fire Extinguishers.

Electrical Safety, Product safety – Technical Requirements of Product safety. Safe handling of chemicals, safety procedures at Nuclear installations.

Health considerations at work place – types of diseases and their spread, Health Emergency.

Personal Protective Equipment (PPE) – types and advantages, effects of exposure and treatment for metal working trades, municipal solid wastes, epoxy resins, 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.

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

AIR QUALITY MODELING AND DESIGN OF AIR POLLUTION CONTROL TECHNIQUES

Subject Code: EVE 210 **CIE: 50**
Credits: 3-2-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 210 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.
EVE 210 CO2: Understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants and to create wind rose diagram.
EVE 210 CO3: Gain Knowledge about the monitoring of particulate matter and carryout experiments on different monitoring tests for ambient air quality parameters.
EVE 210 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.
EVE 210 CO5: Understand and analyze the basic mechanisms involved, working principles and design aspects of various air pollution controlling equipment's through demonstration.

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.

Meteorology: Wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth, Ventilation coefficient, Temperature Inversions, plume behavior, Wind rose diagram, general characteristics of stack emissions, heat island effect.

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.

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 height calculations.

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 criteria with design

Control Equipment for gaseous pollutants – adsorption, absorption, condensation and combustion. Design principles.

Indoor Air Pollution : Sources, indoor air contaminants, effects and control. air changes per hour (ACH), IAQ Standards.

Lab Component

- 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.

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. andSincero, G.A. (1999), "Environmental Engineering - A Design Approach",Prentice Hall of India, New Delhi.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

Subject Code: EVE 220 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 220 CO1: Explain the Constitution of India, National Environmental policy and Legal framework related to environmental aspects.
EVE 220 CO2: List and identify various Indian Environmental Acts in vogue, Amendments, modifications and notifications. Describe the Role of Green Tribunal.
EVE 220 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.
EVE 220 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.
EVE 220 CO5: Distinguish between EMP and DMP. Lists and explains Contents of EMP & DMP. Review important case studies.

Environmental Legislation: Introduction & need, Constitution of India, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (Green Tribunal) Legal Framework, Legislative act, rules, regulations notification and amendments

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

Environmental Impact Assessment: Carrying capacity concept and Environmental Impact Assessment – Objectives, Types - Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of

Significant Deterioration Programme. Frame work of Impact assessment, scope and contents of EIA, methodologies and techniques of EIA, Public participation in EIA.Attributes, Standards and Value functions. Impact prediction models for various attributes.

Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

EIA Case Studies – Pharmaceutical, Thermal Power Plant, Mining, Construction Projects, Airports and Environmental Projects – Water and Wastewater Treatment Plants.

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 Asseessment Methodologies”, BS Publications, Hyderabad.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

TRANSPORT PROCESSES AND MODELLING

Subject Code: EVE 230 **CIE: 50**
Credits: 3-2-0 = 5 **SEE: 50**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 230 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.
EVE 230 CO2: Apply mathematical models and predict pollutant (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions; solve simple numerical problems.
EVE 230 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.
EVE 230 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.
EVE 230 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.

Modelling – Introduction, applications in environmental management.

Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion, convective - diffusion equations for turbulent & shear flow regimes.

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.

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.

Data collection and analysis - specialized water quality surveys, estimation of decay and re-aeration rates.

Dissolved oxygen models for lakes under completely mixed and stratified conditions.

Estuaries – Salinity distribution, mathematical analysis of pollutant dispersion in estuaries. Ocean - disposal of wastewater - siting and design of outfalls.

Ground water quality modeling concepts - formulation of 1-D model with decay and retardation for instantaneous sources, plume delineation studies.

Salient features of environmental simulation models / software.

Lab Component

- 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

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

BIOLOGICAL TREATMENT PROCESSES LAB

Subject Code: EVE 270 **CIE: 50**
Credits: 1.5

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

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 270 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.
EVE 270 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.
EVE 270 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 analyzing, interpreting and inferring the laboratory data.

EXPERIMENTS

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

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, Chiffs, 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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITIES (ELECTIVE III)

Subject Code: EVE 241 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 241 CO1: Know the need, types, basic principles, organizational structure, work planning and scheduling and cost estimates of O&M
EVE 241 CO2: Explain the importance of drawings, plans, record keeping. Recognize the need for operational manual and SOP. Discuss the advantages and limitations of SCADA based control systems
EVE 241 CO3: Identify and list the operational problems in water treatment and supply facilities. Apply preventive and corrective maintenance measures
EVE 241 CO4: Describe the operational problems in wastewater collection and treatment facilities. Enumerate the remedial measures. Explain the problems and control measures in Industrial wastewater treatment facilities
EVE 241 CO5: Identify and discuss the troubles in air pollution control systems and suggest the preventive and control measures

Importance of Operation & Maintenance, Basic Principles, Objectives, Requirements, Corrective and Preventive Maintenance.

Operation & Maintenance Planning - Organizational Structure, Work Planning, Preparation and Scheduling, Cost Estimates.

Data Base of Facilities for O&M – Detailed Plans, Drawings, Operation Manuals, Record keeping, standard operating procedure and Computer Applications in O&M and SCADA.

O&M of Water Treatment and Supply and Facilities, Operational Problems and Corrective Measures in Different Units of Treatment. Water Distribution Network

O&M of Wastewater Collection and Treatment Facilities, Operational Problems and Corrective Measures in Different Units of Treatment, sewer network system. O & M of Industrial wastewater systems.

O&M of Air Pollution Control Facilities, Operational Problems and Corrective Measures in Different Units of Treatment.

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.

REFERENCES

- Training Manual on O&M for Municipal Staff, Asian Development Bank Project, Government of Karnataka.
- CPHEEO Manual, (1991) "Water Supply & Treatment", GOI Publication.
- CPHEEO Manual., (1995) on Sewerage & Sewerage Treatment, GOI Publication.
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial Safety and Pollution Control Handbook"
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

DESIGN OF ADVANCED WASTEWATER TREATMENT PROCESSES (ELECTIVE III)

Subject Code: EVE 242 **CIE : 50**
Credits :4-1-0 = 5 **SEE :100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 242 CO1: Acquire knowledge of residual pollutants in the effluent of conventionally treated wastewater and their removal by various advanced processes
EVE 242 CO2: Describe different combinations of hybrid reactor systems and to design them for a given situation
EVE 242 CO3: Apply the knowledge of nutrients removal using advanced wastewater treatment processes design
EVE 242 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
EVE 242 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.

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

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

Nutrients' Removal from Wastewaters: Nitrification and denitrification, physicochemical and biological phosphorus removal, SBR.

Sludge: Chemical Sludge – Sources and generation, types, characterization, recovery of metals, and alternate uses

Biological sludge – Sources and generation, characterization, utilization possibilities – compost

Recent Trends

Environmental Biotechnology **-** genetically engineered microorganisms for wastewater treatment, bio remediation, bio sensors, membrane bio reactors (MBR), power generation from wastewater.

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.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

GLOBAL WARMING AND CLIMATE CHANGE
(ELECTIVE III)

Subject Code: EVE 243 **CIE : 50**
Credits: 4-1-0 = 5 **SEE : 100**

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.

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 243 CO1: Review earth's climate change, identifies the causes for climate change. Introduces the climate change models and their application.
EVE 243 CO2: Describe impacts of climate change on various environm compartments. Stresses the need for vulnerability assessment and its approach.
EVE 243 CO3: Explain the Indian scenario of climate change and its impact. Reviews various impact predictive models.
EVE 243 CO4: Define & describes emission trading, distinguishes different types of emission trading, understands the consequences of emission trading.
EVE 243 CO5: Highlight the need for emission trading, Describe emission trading mechanisms; suggest monitoring and enforcing agencies, their role and responsibilities in emission trading.

Introduction: Earth's climate, climate change, drivers of climate change, Kyoto Montreal and New Delhi Protocols

Climate models: Models for climate change, GCMs, RCMs, climate change scenarios; Sector models – water resources, Agricultural, forestry, energy, GHG prediction models

Climate change impacts: Impacts of climate change on water sector, agriculture sector, infrastructure and energy systems with case studies

Vulnerability/adaptation: Need for vulnerability assessment; generic steps, approaches and tools of assessment; adaptation to climate change by various sectors

Mitigation: Mitigation measures for climate change, CDM and case studies

Climate change and India, impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India;

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

Monitoring and enforcement: domestic enforcement process, nature of international enforcement process, economic enforcement, current enforcement practice, program effectiveness

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
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

VULNERABILITY ASSESSMENT AND DISASTER MANAGEMENT (ELECTIVE IV)

Subject Code: EVE 251 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 251 CO1: State and classify disasters and identify the cause – effect relationships.
EVE 251 CO2: Apply the knowledge of vulnerability assessment for pre-planning, early warning systems and response plan. Prepare on – site and off –site ERPs.
EVE 251 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
EVE 251 CO4: Consolidate the information on National policy on disaster management along with required legal framework for effective mitigation
EVE 251 CO5: Comprehend the lessons learnt from different natural and manmade disasters leading to newer initiatives for forecasting, planning and mitigation

Introduction: Disasters, causes and impacts, scope of disaster management, disaster Managers – professionals and specialists active in various phases of disasters, Risk management, Loss management, Preparedness, operational functions of disaster management, Equity assistance, Resource management, impact reduction.

Disasters: Natural disasters - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami; Manmade –Armed conflicts and Civil Strife, Air accidents, Rail and Road accidents, Industrial, Chemical, Biological. Accidental oil spills on land and water. Nuclear and Space Debris, Management of Chemical (Terrorism) Disasters, guidelines. Other types of Disaster - rapid-onset or cataclysmic disasters, and long term or continuing disasters.

Vulnerability Assessment and Disaster Preparedness: Vulnerability assessment. Importance and advantages, Process of VA, Steps in VA, VA Report, Prioritization, Emergency Response Plan (ERP) – on-site and off – site ERP.

Pre disaster planning for earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction. Coping mechanism and relief assistance, disaster continuum, early warning and management. Flood forecasting, flood control systems. Disaster Assistance Modelling.

Disaster Prevention and Mitigation: Earthquake mitigation, Cyclone mitigation, Landslide hazard mitigation, Flood preparedness and response, National Disaster Management Policy, Legal Frame work. Disaster Management Plans (DMP).

Technology in Disaster Management – Simulation studies. GIS for Disaster Management, Mapping, Aerial Photography, Remote sensing, communications, Information Technology, logistics, Epidemiology, meteorology, use of UAVs in disaster management and monitoring.

Case studies: Natural, Industrial, Nuclear, Biological, Ocean Oil Spills, Accidental Hazards

TEXT BOOKS

- Peter R.J. Trim, (2004), "An Integrative Approach to Disaster Management and Planning", Emerald Group Publishing Ltd.,
- Ramesh R. Rao, Jon Eisenberg, and Ted Schmitt, Editors, Committee on Using Information Technology to Enhance Disaster Management, National Research Council "Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery", The National Academies Press, Washington, D. C.
- Committee on Planning for Catastrophe, (2007)," A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, National Research Council, "Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management", The National Academies Press, Washington, D. C.

REFERENCES

- Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities, "Facing Hazards and Disasters- Understanding Human Dimensions" Division on Earth and Life Studies, (2006), The National Academies Press, Washington, D. C.
- Patricia Jones Kershaw and Byron Mason, (2005), "The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness - Summary", the National Academies Press, Washington, D. C.
- UNEP Report,(2005),"ENVIRONMENTAL MANAGEMENT AND DISASTER PREPAREDNESS" Lessons Learnt from the Tokyo Typhoon (Typhoon 23 of 2004) in Japan
- UNEP Report, "Environmental Management and Disaster Preparedness" Building a multi-stakeholder partnership.
- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented material

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

Subject Code: EVE 252 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 252 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
EVE 252 CO2: Explain source tracking and transport and fate of ground water pollution and assess influence of urbanization on pollution quantification and its movement
EVE 252 CO3: Apply available area and line source models for quantifying fugitive emissions from different air pollution sources
EVE 252 CO4: Have a thorough understanding of qualitative and quantitative aspects of non point source pollution from agricultural and mining areas
EVE 252 CO5 : Effectively use the simulation models for pollution quantification and to evaluate the impacts of best management practices

Introduction: Problem and magnitude, Surface Water Problems, Waste Assimilative Capacity and In-stream and Effluent Discharge standards.

Hydrologic Considerations: Introduction, Precipitation – Runoff Relationship. Overland Routing of the Precipitation excess, Interflow, Groundwater flow. Pollution from the Atmosphere – Atmospheric Input.

Groundwater Pollution: Sources of Groundwater Contamination, and Groundwater Movement.

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.

Pollution from agricultural and mining areas: Quantification and qualitative analysis.

Non-point Pollution Simulation Models: Basic Concepts, Brief Description of Non-point Pollution Simulation Models

Comparative Assessment of Pollution Impact from land uses, Land-use and non-point sources of pollution.

Best Management Practices of Non-point sources of pollution control.

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.

REFERENCE

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

REMOTE SENSING AND GIS
(ELECTIVE IV)

Subject code: EVE 253 **CIE: 50**
Credits: 4-1-0 = 5 **SEE: 100**

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

Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

COs - LOs
EVE 253 CO1: Describe the concepts and principles of remote sensing and remote sensing systems including EM spectrum, RS satellites and resolutions.
EVE 253 CO2: Interpret satellite images by applying the concepts of elements of visual image interpretation; explain the methodologies of image preprocessing, enhancement, filtering, transformation and classification; analyze the need for the application of these processing techniques.
EVE 253 CO3: Recognize the importance and need of GIS in environmental management; explain the concepts of co-ordinates and projection system and examine their relevance.
EVE 253 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.
EVE 253 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.

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

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

Image interpretation and processing: Visual image interpretation; concept of color, color composites, Preprocessing, image registration, image enhancement, spatial

filtering, image transformation, image classification

Geographical Information System (GIS)

Introduction: Origin and importance of GIS; scale; coordinate and projection systems, Linkage of Remote Sensing to GIS

Data Models and Structures: Spatial data models – Raster, vector; spatial and attribute data.

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.

Spatial Analysis; Raster and Vector overlay analysis; Terrain modeling; Spatial interpolation; Buffering and Neighborhood function, Networks;

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

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 articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.