WATER TREATMENT AND SUPPLY ENGINEERING

Sub Code: EV 510 **CIE: 50**
Credits: 04 **Exam Hours: 03**
Exam Marks: 100

Course Objective: The student acquires mastery in computing population and water demand, describes types of water supply schemes, water quality parameters and standards. Provides the knowledge on the principles, design of unit operations and processes in water distribution system. Exposes to the recent trends in water treatment and supply system.		
Course outcomes **Students will be able to:**		**Domains** **(Revised)**
CO1	Able to comprehend water quality standards and parameters and solve numerical problems related to population forecasting and water demand calculation	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Understands the basics of unit operations and processes, design criteria of various treatment options	
CO3	Gains the know-how of flow schemes, water demand, water intake structures and their design aspects	
CO4	Have an in-depth knowledge of water supply network system, quality aspects in distribution network, pipe materials and pumps and pumping station	
CO5	Ability to design unit operations and processes, small network through simple numerical problems and understands the need for advanced water treatment with automation in treatment and supply	

COURSE CONTENT

Water Sources, need for water supply schemes-types and objectives. Drinking water quality parameters, guidelines and standards – International, national, regional and local. **04**

Population forecasting methods, limitations and numerical problems. **04**

Water treatment

Unit operations and processes, treatment flow sheets for different sources of water. **03**

Design principles of aeration, sedimentation – types of settling, sedimentation with coagulation and flocculation, pulsators, filtration and disinfection. **10**

Miscellaneous treatment- defluoridation, water softening, arsenic removal –numerical problems. **04**

Water Supply and distribution

Water demand, design period, peak factor. Water Intakes- types and design aspects. **04**

Pumps and pumping station. Collection and conveyance, gravity and pressure flows, appurtenances. Service reservoirs and service connection (ferrule). Corrosion-prevention and control – Langelier's Index. **06**

Pipes and pipe materials, Rising main economics, Hydraulic transients, Hazen-William equation, Manning's equation, Cole Brooke-White equation. Distribution system - types. Hardy- cross and Newton-Raphson methods of pipe design. Simple problems. **10**

Recent trends
Advanced water treatment, automation in treatment and supply, economics, Package treatment units and patented material, implications of 24x7 supply, Intermittent residual chlorine boosting in the water distribution system, water quality in distribution system. Application of nanomaterials in water treatment. **05**

TEXTBOOKS

- Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., (1986), "Environmental Engineering", McGraw Hill Book Co.
- Viessman W, HammerM.J., Perez E.M., Chandik P.A., (2009), 'Water supply and pollution control' eighth edition, PHI Learning Private Ltd., New Delhi

REFERENCES

- CPHEEO manual on water supply and treatment (recent edition)
- Weber M.J. (1974), "Physico chemical Processes", McGraw Hill International

WASTEWATER ENGINEERING - I

Sub Code : EV 520 **CIE : 50**
Credits : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course builds the foundation to rural and urban sanitation, provided the knowledge on principles and design aspects of wastewater collection, treatment and disposal systems, updated with the latest technological advancements.

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Describe the salient features of rural and urban sanitation systems, compare and contrast between the types of sewerage system, describe the characteristics of wastewater, estimate dry and wet weather flow of domestic wastewater.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Recognize the importance of self-cleansing and non-scouring velocities, describe the characteristics of hydraulic elements curves, design hydraulics of sewer system, and identify suitable sewer appurtenances.	
CO3	List, explain and apply the design principles and criteria for screening, grit chamber and primary settling tank.	
CO4	Determination of bio-kinetic coefficients and types of reactors. Describe the design criteria and design suspended and attached growth biological wastewater treatment systems like ASP, trickling filter, RBC, SBR, secondary sedimentation.	
CO5	Design wastewater treatment systems for rural areas. Explain the applicability of natural systems for wastewater treatment. Explain sludge characteristics and design the facilities for biological sludge handling and treatment. Describe the concepts of tertiary/ advanced wastewater treatment systems.	

COURSE CONTENT

Introduction: Need for sanitation, Urban and rural sanitation systems. Sources of domestic wastewater, Types of sewerage systems. Characteristics of wastewater. **04**
Estimation of dry and wet weather flow, Evaluation and Selection of design mass loading, Estimation of storm water flow, Simple problems. **02**

Hydraulic design of sewers

Hydraulic formulae, self-cleansing and non-scouring velocities, hydraulic elements curve, Design of sewers. **06**

Sewer Appurtenances

House drainage connection,- Tee, bends, closets, traps, manholes, inverted siphons. Materials of sewers, laying, joining and testing**.** **04**

Wastewater Treatment

Objectives, Unit operations and unit processes, process flow sheets. Chemical and Biological reaction kinetics, Determination of bio-kinetic coefficients and types of reactors. **04**

Unit Operations

Pumps, screens, equalization, comminutor, grit chamber, oil and grease removal, primary sedimentation tank, design criteria and examples. **04**

Unit Processes

Aerobic, Anoxic and Anaerobic systems, Suspended and attached growth systems, activated sludge process and modifications, trickling filters, rotating biological contactors, SBR, secondary sedimentation, design criteria and examples. **10**

Presence of nutrients and its importance in Wastewaters

Nitrification and denitrification process, Role of phosphorus in wastewater treatment.

Natural Wastewater Treatment Systems: Root Zone Systems, Waste stabilization ponds, wet lands, aerobic and anaerobic lagoons, septic tanks and soak pits. **04**

Municipal Sludge Treatment: Quantification and characteristics, SVI, CSI, sludge digestion–aerobic and anaerobic, quantification of Methane, sludge thickeners, sludge drying beds, sludge filter press, design criteria and examples. **08**

Recent Trends in Wastewater Treatment

Decentralized wastewater treatment Systems – DWATS: Introduction, Principles, Design of Modules, Concepts and design, Construction, post implementation and sectors of application, Tertiary and advanced wastewater treatment systems. **04**

TEXT BOOKS

- Metcalf and Eddy, (2003), "Wastewater Engineering, Treatment and Reuse", 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi
- Karia G.L., and Christian R.A., (2001), "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.

REFERENCES

- Quasim, S.R., (1985), "Wastewater Treatment Plants – Planning, Design and Operation", Holt Rinehart and Winston, CBS College Publishing.
- Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., (1986), "Environmental Engineering", McGraw Hill Book Co.
- CPHEEO Manual on Wastewater Treatment (Recent Edition)
- 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.

MUNICIPAL AND BIOMEDICAL WASTE MANAGEMENT

Sub Code : EV 530 **CIE Marks : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The student will have a thorough understanding of key functional elements in municipal solid waste management including waste minimization concepts. The course also provides a comprehensive knowledge on biomedical waste management practices incorporating the role of private public partnerships

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to identify improper practices of solid waste disposal and their environmental implications. Understands the basic engineering principles of solid waste management	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Understands the need for economics in collection and transportation of solid waste and clearly describes various types of collection systems and able to analyse system dynamics	
CO3	Appreciates the management concepts, stresses on 4R approach, PPP model and community involvement for effective management of municipal solid and biomedical waste.	
CO4	Develops a concise idea on various conventional and advanced treatment options for both municipal and biomedical waste	
CO5	Able to understand and apply the design aspects of engineered disposal options and apply the gained knowledge to solve numerical examples.	

COURSE CONTENT

Introduction

Objectives, principles, functional elements of municipal solid waste (MSW) management system – major problems. Environmental implications of open dumping of MSW, MSW rules, Construction debris – management & handling. Rag pickers and their role. **04**

Engineering Principles

Waste generation rates, frequency, storage and refuse collection, processing at source, physical and chemical composition, quantity of waste, engineering properties of MSW waste prediction, modeling concepts. **06**

Collection and Transport

Access and point of collection, primary and secondary collection – economics. Equipment types, personnel, collection routes – optimization, transfer stations (regional concepts). System dynamics, problems. **08**

4R – Reduce, Recovery, Recycle and Reuse

Source segregation. Waste minimization, Recovery potential and recycling practices, recycle of non-biodegradable materials, reuse cycles. **06**

Biomedical Wastes (BMW)

Health care systems, sources, categories, generation and handling of BMW. Segregation, BMW (Management and Handling) Rules 2011/12 **06**

Recent trends

Community based waste management, Waste as a Resource concept, Public private partnership (PPP) in MSW and Biomedical Waste Management. **04**

Treatment Options for MSW and BMW

Composting, Vermi-composting**,** bio-gasification, Thermal processing – combustion, incineration, pyrolysis, - types and design criteria, Plasma technique. Radio-active waste containment **10**

Disposal options

Engineered Sanitary landfills–gases and leachate control, Opportunity costs, siting considerations and design, problems. Sharps and needles disposal. **06**

TEXT BOOKS

- Tchobanoglous G., Theisen H., and Vigil S. (1993), "Integrated Solid Waste Management – Engineering Principles and Management Issues", McGraw Hill Inc., New York
- Flintoff F., (1976), "Management of Solid Wastes in Developing Countries", WHO Regional Publications, South East Asia, New Delhi

REFERENCES

- Sasikumar K and SanoopGopi Krishna, (2009), "Solid Waste Management", Eastern Economy Edition, PHI, New Delhi
- CPHEEO manual on Municipal solid waste management (recent edition)
- Bhide and Sundareshan, (1985), "Solid waste management in developing countries", UN publications
- MSW and BMW –rules and guidelines (CPCB and KSPCB)

OCCUPATIONAL SAFETY AND HEALTH

Subject Code: EV 540 **CIE Marks : 50**
Hrs/ Week : 03 **Exam Hours : 03**
Exam Marks : 100

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

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student gains knowledge on safety principles, right-to-know laws and manages situation applying theories of accident at workplace	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Ability to develop skill of understanding the ergonomics and address specific problems with appropriate strategies	
CO3	Able to identify, analyse the hazards using various techniques and prepare preventive plans. Also, understands the hazards in selected industries and suggests remedial measures for their control	
CO4	Describes the need for product safety and its importance and acquires knowledge on various aspects of fire- types, prevention and protection	
CO5	HaveanexposuretoHealthandSafetyConsiderationsatdifferentworkplaceswith a thorough understanding of ISO series of standards and Corporate Social Responsibility.	

COURSE CONTENT

INTRODUCTION: History and development, Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws, Principles of Safety and Safety Triangle, Introduction to Factories Act 1948. **04**

ACCIDENT CAUSATION: Type of accidents, Causes of accidents, work injuries, deaths in Work Accidents. **04**

THEORIES OF ACCIDENTS: Domino, Human Factor, Petersen's Accident Incident, Epidemiological, Human Error Model and Combination theory. **04**

ERGONOMICS: Definition, factors associated with physical stress, worksite analysis programme, hazard prevention and control. Specific ergonomic problems and problem solving strategies, economics of ergonomics, visual ergonomics. **06**

OCCUPATIONAL HAZARD AND CONTROL: Hazard identification, Hazard Analysis, Human Error Analysis in Causation with Hazard Analysis, Fault Tree Analysis and

problems. Emergency Response, Decision for Action, Purpose and Considerations. 06 Engineering Versus Management Control, Hazard Control Measures, Hazards and their Control in Pharmaceutical, Construction, Textiles, Petroleum Refineries and LPG Bottling, Iron & Steel Industries. **08**

FIRE PREVENTION AND PROTECTION: Fire Development and its Severity, Effect of Enclosure, need for early Detection of Fire, Extinguishing Fire, Electrical Safety, Product Safety, and Technical Requirements of Product Safety Programme. **06**

OCCUPATIONAL HEALTH: Health and Safety Considerations, Personal Protective Equipment, Effects of Exposure and Treatment for Metal Working Trades, Municipal Solid Waste, Epoxy Resins, and Foundries. Occupational Health and Safety Considerations in Wastewater Treatment Plants, Epidemiological Survey. **08**

RECENT TRENDS: ISO 14000 series and ISO 18000 series. Corporate social responsibility and its rating, Introduction to BBS. **04**

TEXT BOOKS

- Colling,D. A.,(1990),"Industrial Safety Management and Technology"–Prentice Hall, New Delhi.
- Goetsch,D.L., (1999), "Occupational Safety and Health For Technologist, Engineers and Managers", 3rd Edition, Prentice Hall, New Delhi

REFERENCES

- Della, D. E., and Giustina, (1996) " Safety and Environmental Management"– Van Nostrand Reinhold International Thomson Publishing Inc
- Anand Gopal Mukherjee,(1986), "Environmental Pollution and Health Hazards"– Causes and Control", Galgotia Publications Pvt. Ltd., New Delhi
- Trescothic,R. A., (1973), "Environmental and Industrial Health Hazards", William Heinemann Medical Books Ltd., London

DISASTER MANAGEMENT

Sub code: EV 550 **CIE : 50**
Hrs /Week: 04 **Exam Hours: 03**
Exam Marks: 100

Course Objective: The course imparts a thorough understanding of natural and man-made disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures stressing the role of modern engineering and information technology. The course also supplements details on the legal framework along with few case studies

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to state and classify disasters and identifies the cause– effect relationships	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Applies the knowledge of vulnerability assessment for pre-planning, early warning systems and response plan	
CO3	Able to appreciate the role of IT in creating vulnerability scenarios through simulation exercises using GIS and other related software and to prepare Disaster and Environmental Management Plans	
CO4	Consolidates the information on National policy on disaster management along with required legal framework for effective mitigation	
CO5	To comprehend the lessons learnt from different natural and man-made disasters leading on newer initiatives for forecasting, planning and mitigation.	

COURSE CONTENT

Introduction
Natural and man-made disasters, causes and impacts. **02**

Types of Disasters
Natural disasters - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami
Manmade - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological. Accidental oil spills on land and water. Nuclear and Space Debris **08**

Disaster Assessment & Preparedness
Vulnerability assessment. Pre disaster planning for earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction.

Coping mechanism and relief assistance, disaster continuum, warning and management. Flood forecasting, flood control systems. **12**

Disaster Prevention and Mitigation

Earthquake mitigation, Cyclone mitigation, Landslide hazard mitigation, Flood preparedness and response, building bye-laws and adaptation. Environmental Management Plans (on site and off site) and Disaster Management Plans (DMP).

Role of Information Technology in Disaster Management – Simulation studies. GIS for Disaster Management. **12**

Legal Framework

Disaster Management Act and Code, National Policy on Disaster Management. **06**

Case studies

Bhopal gas tragedy, Meuse valley, Chernobyl, Fukushima, Tsunami, Forest fires, Gujarat earthquake, Gulf of Mexico Oil Spill and recent episodes. **10**

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.
- Committee on the Effective Use of Data, Methodologies, and Technologies to Estimate Sub national Populations at Risk, National Research Council, (2007), "Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises", 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

Remote Sensing and GIS in Environmental Engineering

Subject code: EV560 **CIE: 50 Marks**
Hrs/Week: 4 **Duration of Exam: 3 Hrs**
Examination Marks: 100

Course Objective: The course lays the foundation for basics of remote sensing, remote sensing systems, and 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 Students will be able to:		**Domains (Revised)**
CO1	Explains the fundamentals and principles of remote sensing and remote sensing systems including EM spectrum, RS satellites and resolutions.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Discuss spatial data acquisition, compare manual interpretation and digital image processing.	
CO3	Explain and illustrate with examples the importance and need of GIS in environmental resources management. Explain the concepts of co-ordinates and projection system, differentiate between raster and vector data models.	
CO4	Identify sources of input data, explain potential errors in input data and illustrate mechanisms of correcting the errors, propose data generalization.	
CO5	Plan and organize the input data for a given application, choose and perform appropriate spatial analysis, and assess the environmental implications of environmental related issues.	

COURSE CONTENT

Remote Sensing (RS)

Basics of remote sensing: Passive and active remote sensing; Radiation sources and radiation principles; Electromagnetic radiation, Electromagnetic spectrum; Energy interactions with atmosphere and Earth's surface; Spectral reflectance curves **05**

Remote Sensing Systems

Ideal RS system, Platforms and orbits; Satellite system parameters; spectral, radiometric, spatial, and temporal resolutions of satellites; multi-spectral RS, Basics of thermal and hyper-spectral sensing; remote sensing satellites **08**

Data acquisition and interpretation

Types of pictorial data products, image interpretation strategy, elements of image interpretation **04**

Digital Image Processing

Preprocessing, image registration, image enhancement, spatial filtering, image transformation, image classification **06**

Geographical Information System (GIS)

Introduction

Origin and importance of GIS; scale; coordinate and projection systems, Linkage of Remote Sensing to GIS **04**

Data Models and Structures

Spatial data models – Raster, vector; spatial and attribute data. **04**

Spatial Data Input and Editing

Methods of data input: keyboard, manual digitizing, scanning and automatic digitizing methods. Electronic data transfer, GPS, Data Editing: sources and correction of errors, concept of topology. **05**

Spatial Analysis

Raster and Vector overlay analysis; Terrain modeling; Buffering and Neighborhood function, basics of Networks **08**

Applications of RS and GIS

Watershed management; Rainfall-runoff modelling; Flood mapping; Environmental monitoring; Groundwater vulnerability modelling; Optional routing of solid wastes collection system of an urban area; Environmental siting and zoning atlas development. **06**

TEXT BOOKS

- Lillesand, T. M., Kiefer, R. W., Chipman, J. W. (2004) " Remote sensing and Image Interpretation", 5th Edition, John Wiley & Sons
- Michael N. Demas (2000) " 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.

DESIGN AND DRAWING OF ENVIRONMENTAL SYSTEMS - I

Sub code: EV 57 D **CIE : 50**

Hrs /Week: 03 **Exam Hours : 03**

Exam Marks : 50

Course Objective: The course reinforces design aspects, drawing skills and capabilities to prepare Engineering drawings of water supply and treatment facility		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	To draw the layout map of water supply system, labelling the details and prepare a typical house plumbing connection	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	To design (functional only) and draw to scale different water intake structures for surface water sources	
CO3	Capable of designing and drawing various functional operating units of water treatment plant	
CO4	Knowledgeable enough to design and draw to scale hydraulic profile of complete water treatment train and ground level reservoir	
CO5	Able to draw and show various components of a typical water distribution system for a small area.	

COURSE CONTENT

Introduction to scales – graphical and numerical scales, scales on CAD.

Design and drawing of the following:

Water supply system for a two storey building –using plumber's chart - layout of water supply system – and ferrule connection.

Bell mouth canal and river / reservoir intakes.

Gravity type circular cascade aeration unit

Parshall flume

Plain sedimentation tank

Clari-flocculator.

Rapid sand filters Sump/GLSR

Hydraulic flow diagram of typical/designed water treatment

Typical drawing of water distribution system.

Deflouridation tank

REFERENCES

- CPHEEO Manual on “Water Supply and Treatment” Ministry of Urban Development, Government of India, New Delhi.
- Raju, B.S.N., (1995), “Water Supply and Wastewater Engineering”, Tata McGraw Hill Pvt. Co. Ltd., New Delhi.
- Quasim, S.R., (1985), “Wastewater Treatment Plants – Planning, Design and Operation”, Holt Rinehart and Winston, CBS College Publishing.
- Hammer, M.J., (1986), “Water and Wastewater Technology”, SI Version, Second Edition, John Wiley and Sons.

ENVIRONMENTAL PROCESS LAB – I

Sub Code: EV 58 L **CIE: 50**
Hrs/Week: 03 **Exam Hrs: 30**
Exam Marks: 50

Course Objective: The lab course provides an opportunity to collect and preserve water samples, conduct various tests on water quality parameters, perform experiments on selected lab scale treatment processes		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	To acquaint with precision and accuracy of analytical data and to appreciate rounding off to a significant value in the Context of water quality parameters, to adopt various sample preservation techniques	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	To determine treatment efficiency of various water treatment processes–aeration, adsorption experiments with isotherms and break through curve, jar test for optimum dose of coagulant and settling experiments	
CO3	To develop the ability to plan and perform filtration experiments, understand the significance of breakpoint chlorination and to plot particle size distribution curve, able to analyze,interpret and infer the laboratory data	

COURSE CONTENT

Process Laboratory - equipment / instruments and applications.

Precision and Accuracy, Significant numbers. Samples' preservation techniques

Aeration Process for Fe and Mn removal, algae removal

Determination of dissolved oxygen.

Adsorption – PAC and GAC, Natural Adsorbents- Isotherms and Break through curve

Water Softening Process.

Jar Test for Optimum coagulant dose

Types of Settling - Column Test

Filtration Process - Single Media and Dual Media Filters.

Chlorine demand, Available chlorine, Residual chlorine and Break Point curve, ozonization

Particle size distribution analysis, Effective Size, Uniformity Coefficient

Household Water Treatment Units– Reverse Osmosis

Bottled water quality analysis

REFERENCES

- Sawyer, C.N., Mc Carty, P.L., and Perkin, G.F., (2003), “Chemistry for Environmental Engineering and Science”, V Edn., Tata McGraw Hill Publishing Company Ltd., New Delhi.

- NEERI Laboratory Manual

- Unit Operations and Unit Processes Laboratory Manual.

- AWWA (2012), “Standard Methods for Examination of Water and Wastewater”, 21st Edition

Computer Applications in Environmental Engineering

Subject Code: EV610 **CIE Marks : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Lecture hours: 50 **Exam Marks : 100**

Course Objective: This unique course lays a strong foundation for the students to appreciate, understand and develop theoretical knowledge related to computer programme writing skills for a variety of environmental engineering applications and stresses the need for CAD and analysis		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student outlines and writes programmes related to population forecasting and water supply and treatment system design	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Ability to develop skill of writing programmers for wastewater collection and treatment units design and understands Streeter-Phelps and other water quality prediction models	
CO3	Gains knowledge to perform exercises related to predicting ground level air pollutant concentrations, effective stack height calculation and design of particulate matter control units through C programming language	
CO4	Acquires theoretical base on CAD, computer graphics and DBMS and their applications in the field of environmental engineering	
CO5	Have an exposure to various software's related to water and air quality prediction, design of water supply system, sewerage system and air pollution control systems.	

COURSE CONTENT

POPULATION FORECAST PROGRAMS: Arithmetic increase method, geometric increase method and incremental increase method. **06**

WATER SUPPLY AND TREATMENT PROGRAMS: Rising main design, pumping unit, service reservoir capacity calculation, Water treatment units design –– Cascade aerator, mechanical rapid mix unit, plain sedimentation tank, clari-flocculator tank, filters (rapid and slow) and disinfection. **10**

WASTEWATER COLLECTION AND TREATMENT UNITS PROGRAMS: Equations used in Sewer design, wastewater treatment units – Screen and Grit chamber, Primary settling tank, Aeration tank and Secondary settling tank of ASP, Trickling filter unit, Sludge drying beds and Septic tank. **08**

AQUATIC SYSTEMS PROGRAMS: Water quality models for discharge of conservative and non-conservative waste in rivers, DO models for rivers (Streeter- Phelps equation). **08**

AIR QUALITY PROGRAMS: Effective Stack height calculation, Gaussian Plume Model for gaseous and particulate dispersion from point sources. Design of particulate control devices – Settling chamber and cyclone separators. **08**

(Writing Flow Sheets, 'C' programme along with Design Steps & Equations is compulsory).

CAD: INTRODUCTION to CAD and its application to Environmental Engineering; Introduction to Computer Graphics – Applications. **02**

INTRODUCTION TO DBMS – Components of DBMS. **02**

INTRODUCTION TO APPLICATION SOFTWARES - RMAIN, WATPLANT, DOWATTS, LOOP, QUALOOP, EPANET, SEWER, STREAM, ISCST/LT, CALINE, MIXING ZONE MODELS, SWMM (storm water management model). **06**

REFERENCES:

1. Thomann, R. V., and Mueller, J.A., (1987), **"**Principles of Surface Water Quality Modeling and Control" –,Harper Int. Edition.
2. Krishna Murthy, C.S., and Rajeev, S., (1998), **"**Computer Aided Design software and Analytical Tools"– Norosa Publishing House.
3. Wark K. Warner, G.F., and Davis, W.T., (1998), **"**Air Pollution its Origin and Control**"**– Addison- Wesley.
4. Sincero, A.P., and Sincero, G.A., (1999), **"**Environmental Engineering – A Design Approach" -Prentice Hall of India.
5. Water Supply and Treatment – CPHEEO Manual (1993), New Delhi.
6. Wastewater Collection, Treatment & Disposal – CPHEEO Manual (1993), New Delhi.

WASTEWATER TREATMENT ENGINEERING - II

Subject Code: EV620 **CIE Marks : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 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

Course outcomes Students will be able to:		**Domains (Revised)**
CO1	Will have knowledge of residual pollutants in the effluent of conventionally treated wastewater and their removal by advanced processes	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Appreciates the need for developing hybrid wastewater reactor systems and their designs	
CO3	Understands and applies the knowledge of nutrients removal using advanced wastewater treatment processes	
CO4	Gets familiarized with the handling and disposal of both biological and chemical sludge from wastewater treatment facilities and able to apply the knowledge of conveyance, design and O&M of faecal sludge treatment.	
CO5	Understands the need for application of environmental biotechnology for wastewater treatment and comprehends the knowledge on recent advanced technologies.	

COURSE CONTENT

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 **10**

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**

Sludge

Chemical Sludge– Sources and generation, types, characterization, recovery of metals, alternate uses, and disposal options.

Biological sludge – Sources and generation, characterization, utilization possibilities. **08**

Sludge Treatment

Sludge Digestion- aerobic and anaerobic, Sludge Drying Bed, Sludge Thickeners,

digestive stability. **08**

Fecal Sludge Management (FSM)

Fecal Sludge- Characteristics; Quantification.

FS Value Chain-Sanitation Value Chain, User Interface, Types of Containment, Transportation, Collection& Conveyance.

Design of a Fecal Sludge Treatment plant; Operation & Maintenance of Fecal Sludge Treatment plant.

Nutrient Recycling Paradigm for Human Waste Management; Implement FSM and schemes; Case studies. **10**

Recent Trends

Environmental Biotechnology**–** genetically engineered microorganisms for wastewater treatment, bio remediation, bio sensors, membrane bio reactors (MBR), Microbial fuel cells, Ozonation, Photo-catalytic oxidation. **04**

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.
- CDD manual on Faecal Sludge Management

ENVIRONMENTAL SYSTEMS OPTIMIZATION

Sub code: EV630 **CIE : 50**
Hrs /Week: 04 **Exam Hours: 03**
Exam Marks: 100

Course Objective: The student appreciates the knowledge gained in this course as it emphasizes the importance of optimization techniques, linear programming, numerical search methods and simulation as applied to environmental engineering problems

Course outcomes Students will be able to:		**Domains (Revised)**
CO1	Able to state, construct and classify optimization problems with and without constraints	1) Remember
CO2	Able to apply various classical optimization techniques applied to environmental engineering.	2) Understand
CO3	Ability to solve linear optimization problems with sensitivity and parametric analysis	3) Apply
CO4	Describes various optimization techniques and apply the knowledge for problems related to air, water, sewer network and solid waste management	4) Analyze
CO5	Precisely understands numerical search methods and simulation techniques	

COURSE CONTENT

Introduction: Definition and Engineering Applications of Optimization. Statement of an Optimization Problem, Classification of Optimization Problems. **04**

Classical Optimization Techniques: Single Variable Optimization, Multivariable Optimization with no Constraints, with equality Constraints and with inequality Constraints (Statement of Theorem without Proof). **08**

Linear programming: Graphical Method, Simplex and Two-phase Method, Big-M Technique, Duality in Linear programming, Sensitivity analysis and Parametric analysis. **08**

Transportation Problem: Definition & Applications of Transportation Model. Solution of the Transportation problem, North West Corner Rule and Vogels Approximation Methods, Application to Wastewater Reuse and Solid Waste Management**.** **08**

Application of Linear Programming: Problems on Air Pollutant Transport, Air Pollution Control, Water and Wastewater Treatment Problems. **08**

Numerical Search Methods: Elimination Methods, Dichotomous Search and Fibonacci methods. **06**

Simulation: Basic Concepts, Development & Implementation of Simulation Process, Pre-simulation Activities, Developmental & Operational Activities and Random Number Generation Techniques. **08**

REFERENCES:

1. Rao. S.S. Optimization Techniques, Wiley, 1984.
2. Fredrick. S. Hiller and Lieberman, Operation Research.
3. CPHEEO. Manual on Water Supply and Treatment.
4. Rich L.G., Environmental Systems Engineering, McGraw Hill, 1973.
5. Jewell T.K., A Systems Approach to Civil Engineering Planning and Design, Harper & Row, 1986.
4. Ravindram, Phillips & Solberg, Operations Research - Principles & Practice, Wiley, 1987.
5. Novotny &Chesters, Handbook of Non-point Pollution Sources and Management, Van Nostrand& Reinhold Publications.

ESTIMATION, SPECIFICATIONS AND FINANCIAL ASPECTS

Subject Code: EV 640 **CIE Marks : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course prepares the student to understand and apply the essentials of cost estimation and specifications, practice value-based engineering profession, and to know basics of financial aspects.

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to estimate volume of earthwork, quantities of building materials and their rate per unit volume.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Understand detailed specification of different components of construction and pipe materials of water supply and sewer system	
CO3	Able to prepare estimate for a variety of environmental engineering construction activities, to know the use of Schedule of Rates and tender documents	
CO4	Describes the need for value engineering and its significance in Engineering Practices	
CO5	Acquires in detail the importance of finance, financial implications including tax and rebates in water and energy sector.	

COURSE CONTENT

QUANTIFICATION AND RATES

Earthwork - volume by cross-section, spot levels and contour – construction of mass diagram, calculation of haul, over haul and economic haul, lead and lift.

Cement mortar, cement concrete, brick and stone masonry, flooring, plastering, RCC works, doors, windows and ventilators. **08**

SPECIFICATIONS

For coarse aggregates, cement, mortars, plain and reinforced concrete, brick masonry, stone masonry, roofing, flooring, plastering, wood work, earthwork and surfing,

water supply distribution lines. Surface and sub-surface drainage line - stone-ware pipes, other materials such as RCC, Steel, PVC,HDPE, etc. **10**

ESTIMATION

Types of estimates, Methods of working out quantities

Preparation of detailed and abstract estimates for - cascade aerators, venturi-flume, septic tank, manhole, pump house, store room.

Quantification of Steel for various basic components -l concrete and BS slabs, chejja

and lintels.

Working out quantities for water supply and sewer network systems, and storm water drains. Use of current Schedule of Rates and tendering. **14**

Principles of value engineering **02**

FINANCIAL ASPECTS

Purpose. Cost, price, value–different forms of value

Balance sheet, Gross income, net income, outgoings – types of out goings – obsolescence, annuity, year's purchase.

Capital cost – fixed and variable, time value of money, NPV, IRR,

Depreciation– methods, sinking fund, cost fixation on the produced commodity.

Debt equity (DE), debt service coverage ratio (DSCR). **10**

FISCAL INCENTIVES AND PENALTY FOR ENVIRONMENTAL PROTECTION

Tax rebate, Investment and Depreciation allowance, exemption from Tax to capital gains, rebate in cess levied on water consumption and energy. **06**

TEXT BOOKS

- Dutta, B. N., (2008), "Estimating And Costing In Civil Engineering" - Ubs Publishers Distributors Pvt. Ltd.,
- Mahajan, S.P., (2006), "Civil Estimating & Costing Valuation & Specifications" – Satya Prakashana.

REFERENCES

- Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2012.
- anual on Sewerage and Sewage Treatment",CPHEEO, Ministry of Urban Development, GoI, New Delhi,
- Current Schedule of Rates (SR) of PWD, KUWS&DB, Irrigation.
- PanneerSelvam, (2005), "Engineering Economics", Eastern Economy Edition.

OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITIES

Subject Code: EV 650 **CIE : 50**
Hrs/ Week : 03 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course encompasses intricate aspects regarding operation and maintenance of environmental facilities		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The learner understands the need for O & M, basic principles, learns organization structure, work plan scheduling and the necessity of automation in environmental facilities	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Able to identity operational problems and develops a plan for corrective measures of water supply and treatment facilities	
CO3	Capable of listing operational problems and providing corrective measures for wastewater collection and treatment facilities	
CO4	Develops sufficient knowledge on operational problems and remedial measures of air pollution control equipment	
CO5	Gains knowledge on O&M of sanitary and hazardous waste disposal facilities.	

COURSE CONTENT

OPERATION, MAINTENANCE & MANAGEMENT

Aims, Basic Principles, Data Base Facilities, Drawings, Detailed Plans, Record Keeping, Organizational Structure, Work Planning and Scheduling, Operation Manuals

Training needs and planning. Automation in O & M of Water and wastewater systems. **08**

WATER SUPPLY FACILITIES

Operational Problems and Corrective Measures for Intakes, pumps, rising mains, Distribution System - Loss of carrying capacity in pipes, Projection of Pipe Break Rates, Leak Detection and control.

Appurtenances – Valves, Hydrants and Fittings. **08**

WATER TREATMENT FACILITIES

Operational Problems and Corrective Measures for Screens, Aeration Unit, Sedimentation Tank, Clariflocculator, Pulsators, Filtration, Disinfection units and

other treatment units, if any. **08**

WASTEWATER COLLECTION FACILITIES

Operational Problems and Corrective measures in Sewer Network, Inspection Methods, Safety Methods**,** Appurtenances and pumps. **08**

WASTEWATER TREATMENT FACILITIES

Operational Problems and Corrective Measures for Screening, Grit chamber, aeration tanks, trickling filters and bio-towers, settling tanks, Sludge Thickener, sludge digesters, sludge drying beds, Disinfection units. **08**

AIR POLLUTION CONTROL FACILITIES

Operational Problems and Corrective Measures for Gravity Settlers, Cyclone Separators, Bag Filters, Scrubbers, Electrostatic Precipitators, and Gaseous Emission Control Devices – Absorption Beds and Adsorption Columns, Thermal Oxidizers, Incinerators.

O & M for sanitary landfills and hazardous waste disposal sites. **10**

TEXT BOOKS

- Metcalf & Eddy Inc, (2003) , "Wastewater Engineering, Treatment and reuse"-4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Training Manual on O&M for Municipal Staff", Asian Development Bank, Government of Karnataka
  CPHEEO, (1999), "Manual on water supply and Treatment", Ministry of Urban Development, GoI, New Delhi.
- CPHEEO, (1999), "Manual on Sewerage and Sewage Treatment", Ministry of Urban Development, GoI, New Delhi.

REFERENCES

- Hammer, M.J., (1986), "Water and Wastewater Technology–SI Version" -2nd Edition, John Wiley and Sons.
- William L Neumann, (1997) "Industrial Air Pollution Control Systems" – McGraw-Hill Professional.
- Walski, T.M. (1987), "Analysis of Water Distribution Systems" – CBS Publications, New Delhi.
- Raju, B. S. N., (1991), "Water Supply and wastewater Engineering by B.S.N. Raju" – Tata McGraw-Hill Publishing Co. Ltd.
- Manual on Solid waste Management" – CPHEEO (Recent edition)

ENERGY AND ENVIRONMENT
(ELECTIVE – I)

Sub Code : EV 661 **CIE: 50**
Hrs/Week : 04 **Exam Hrs : 03**
Exam Marks : 100

Course Objective: The course imparts knowledge on different types of energy sources, energy scenario, alternative energy resources and associated environmental impacts.

Course outcomes Students will be able to:		**Domains (Revised)**
CO1	The student will have a thorough understanding and ability to recognize environmental resources, energy necessity and energy crisis. Have the ability to distinguish between renewable and non-renewable energy.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	The student will learn thoroughly hydroelectric and tidal energy production along with their impacts on environment.	
CO3	The student appreciates the necessity and implications of solar and wind energy in the present context and develops know-how of energy production.	
CO4	Imbibes the basic knowledge on geothermal and nuclear energy aspects and will be able to assess the environmental effects.	
CO5	Acquires knowledge on the availability, uses and generation of natural and biogas as energy supplements and will be able to identify appropriate methods for societal use and current knowledge on hybrid systems..	

COURSE CONTENT

Introduction to Energy Sources: Global Energy, Environmental Resources, Energy necessity and energy crisis, implications of growing energy consumption on the environment, policies and how they drive energy economics and markets, Define global and national energy policy factors which promote sustainable energy systems
Indian Energy Scenario: Energy Consumption, needs and crisis, energy sources and availability, case studies. **06**

Biomass: introduction, energy plantation, agricultural residue, urban organic waste, Cultivation of algal biomass from wastewater and energy production from algae. bio-mass conversion technologies (wet and dry process). **06**

Hydropower: Site selection for hydroelectric power plants, classification of hydroelectric power plants, submergence, ecological imbalance, advantages and

disadvantages of hydroelectric power plants, catchment area assessment.
10

Tidal Energy: OTEC (Ocean Thermal Electric Conversion), methods of ocean thermal electric power generation, site selection. Energy from tides – basic principles of tidal power, components of tidal power plant. **05**

Solar Energy: Solar constants, solar radiation at earth surface, physical principles of conversion of solar radiation into heat. Concentrating collectors (focusing and non-focusing), Associated Environmental Effects, Solar energy economics, financing, policies and regulations
10

Wind Energy: Introduction, basic principles of wind energy conversion. Site selection considerations.Basic components of wind energy conversion system. Wind energy collectors.

Geo-thermal Energy: introduction, nature of geothermal fields, geo-thermal sources, binary fluid geo-thermal power system and arrangement for hybrid plants **04**

Nuclear Energy: necessity, general components of nuclear reactors, different types of reactors, breeding reactors, location of nuclear power plants, disposal of nuclear wastes, Associated Environmental Effects.
05

Natural gas: classification and comparison of different gas turbine power plants, Associated Environmental Effects. **02**

Co-generation – energy production from wastes through incineration, pyrolysis and gasification, energy production from waste plastic, energy production from organic waste through anaerobic digestion and fermentation, introduction to microbial fuel cells. Energy production from wastes through fermentation and trans-esterification.

Fuel cell types, Fuel processing, concept to product. Characterization and durability of fuel cells **04**

Hybrid system
Perform a basic scenario analysis with an energy forecasting tool (LEAP)
Alternative Energy in Transport – fuels, electric vehicles.
Investigation of renewable energy options in higher education institutes. **04**

TEXT BOOKS

- Mathur, A.N., and Rathore, N.S., (1990), “Renewable Energy and Environment”, Proceedings of the National Solar Energy, Himansu Publications, Udaipur.
- Rao and Parulekar B.B., (1977), “Energy Technology – Non-conventional, Renewable and Conventional”, 2nd Edition, Khanna Publishers.

- Energy and the Environment (2006) by Robert A. Ristinen, Jack P. Kraushaar
- Energy and the Environment: Sources, Technologies, and Impacts (2008), Reza Toossi

REFERENCES

- Rai, G.D., (1999) “Non-conventional Energy Sources”, 3rd Edition, Khanna Publications, New Delhi.
- Saha, H., Saha, S.K., and Mukherjee, M.K., (1990), “Integrated Renewable Energy for Rural Development”, Proceedings of the National Solar Energy Convention, Calcutta, India,
- Wilber, L.C., (1989), “Handbook of Energy Systems Engineering”, Wiley and Sons.
- The Energy Research Institute (TERI), New Delhi, Publications.
- Ministry of Environment and Forests, Government of India, Annual Reports.

HAZARDOUS WASTE TECHNOLOGY
(ELECTIVE-I)

Sub Code : EV 662 **CIE : 50**
Hrs/ Week : 04 **Exam Hours: 03**
Exam Marks:100

Course Objective: The course provides the student an insight into fundamentals, listing and characterization of hazardous wastes. It also supplements the techniques for waste minimization, storage and transportation as well as treatment and disposal.		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student describes the sources, generation and classification of hazardous waste. Gets a thorough understanding and ability to apply national and international acts, rules and regulations for effective management practices.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	The student defines the typical characteristics of hazardous wastes and able to develop a protocol for toxicology and risk assessment studies.	
CO3	The student appreciates the necessity and implications of Waste Minimization, Resource Recovery and Life cycle assessment and also understands the Hazardous wastes transportation regulations.	
CO4	Able to apply various treatment options available for safe handling and disposal of hazardous waste.	
CO5	Gets a feel of sources and generation of e-waste along with recovery and reuse. Gains knowledge on site remediation aspects including bioremediation	

COURSE CONTENT

Introduction: Definition, History-Times Beach, Love canal, Sevaso Dioxin accident. Sources /generation of Hazardous wastes, Classification of Hazardous wastes. Bio-medical wastes, Household hazardous wastes, e-waste. **08**

Regulations: Basal Convention, HSW (Management & Handling and trans-boundary movement) Rules, CERCLA, Super fund Amendments and Reauthorization Act (SARA),

Superfund law, National Priority law (NPL), Hazard Ranking System (HRS), National Contingency Plan (NCP), RCRA, Cradle to grave concept, Assessment of Hazardous waste sites. E-waste (management & handling) rules. **06**

Characterization of Hazardous wastes: Ignitability, Corrosivity, reactivity, toxicity. Designated Hazardous wastes. **02**

Toxicology and Risk Assessment: Toxic effects, Dose response assessment, Risk exposure assessment, Carcinogenesis, ecotoxicology, risk characterization. **06**

Waste Minimization and Resource Recovery: Life cycle assessment, Elements of waste minimization strategy, waste reduction techniques, Benefits of waste minimization. Case studies on by-product recovery- Plating and solvent. Development of waste tracking system. Waste compatibility for storage, treatment and disposal.

06

Transportation of Hazardous wastes: Regulations for hazardous materials, Bulk and Non-bulk transport, Hazardous substances emergency response. **04**

Physico-chemical and Biological Treatment: Air stripping, soil vapor extraction, carbon adsorption; steam stripping, Solidification and Stabilization, Thermal methods- combustion, Incineration, Biological methods- conventional treatment, in-situ bio-remediation, slurry phase treatment and solid phase Treatment. **08**

Land Disposal: Landfill operations, site selection, liner and leachate collection systems, Cover systems, Contaminant transport through landfill barriers, landfill stability, closure and post closure care, other types of disposal facilities.

06

e-waste: Dismantling, recovery, reuse and recycle, treatment and disposal, as per regulations. **02**

Site remediation: Site inspection, assessment, and remedial action, monitoring of disposal sites.

Thermal processing – combustion, incineration, pyrolysis, - types and design criteria, Plasma technique. Radio-active waste containment **02**

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.
- Davis M.L., and Cornwell D.A. (1998),"Introduction to Environmental Engineering", McGraw Hill International Edition
- CPCB guidelines for Hazardous Wastes

LIFE-CYCLE ANALYSIS & RISK ASSESSMENT

Sub Code : EV 663 **CIE: 50**
Hrs/Week : 04 **Exam Hrs : 03**
Exam Marks : 100

Course Objective: The course deals with sufficient information on need and principles of environmental life cycle assessment, risk, assessment methodologies, environmental modelling for monitoring, assessing and quantifying risks through dose-response relationships		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to define terminologies, understands life cycle approach analysis and risk assessment models. Performs the process of risk assessment and develops knowledge on exposure assessment models	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Appreciate and understand various release assessment models and monitoring methodologies including statistical models	
CO3	Apply various testing methods for exposure assessment in different environmental systems and human exposure models. Gets a fair knowledge of their strengths and limitations	
CO4	Outlines various modelling methods for assessing health consequences and understands the impact of influencing agents on environment	
CO5	Capable of analysing and evaluating risk estimation uncertainties, completeness, accuracy and practicality of risk assessment.	

COURSE CONTENT

Life-cycle Analysis - Concept & fundamentals

What is LCA?, History of LCA, Goals and principles of LCA, Design principles of LCA, Conceptual framework, Pollution prevention and LCA, Applications. **03**

Application of LCA in Environmental Management

Strategic planning, application in public sector, Industrial applications, Case study on municipal solid-waste management practices, LCA in plastic manufacturing industry, Environmental performance and LCA in product development**.** **03**

Risk Assessment

Terminology and definitions, Environmental problems, Resources and environmental issues, Risk sources and agents, Effects of risk agents on human health and environment, Soundness-Completeness-Practicality-Effectiveness of risk assessment. **05**

Methods of Environmental Risk Assessment

Statistical models - Component failure & initiating event models, Hypothesis testing - *Strengths & limitations*. **Release assessment models** - FMEA, Fault tree, Event tree analysis, Discharge models - *Strengths & limitations***.** **04**

Exposure models - Atmospheric models, surface water models, groundwater models, watershed runoff model, food chain models, multimedia models - *Strengths & limitations***.** **03**

Consequence assessment models - Dose response, dynamic models, matrix models, stochastic models, Markov models, Population response - *Strengths & limitations*. **Risk estimation** - Classical methods, Propagation of uncertainty by method of moments, Monte-Carlo method, Response surface and probability trees. **08**

Evaluation of Environmental Risk Assessment

Risk indices, Source uncertainty, Qualitative analysis, Accuracy of assessment, Acceptability-Limitations-Credibility & Failure of risk assessment, Standardization of risk assessment, Accounting of uncertainty and Conservationism**.** **08**

Risk Assessment of Natural Calamities

Considerations for risk assessment of natural calamities such as O-Zone depletion, Global warming, River flooding, Forest fires and Earthquakes**.** **08**

Risk Assessment of Anthropogenic Activities

Resource depletion, Heavy metal contamination of soil and groundwater, Radio-active contamination, mining, MSW dump, major transport corridors on forest and wild life, Military conflicts and wars, Nuclear reactors**.** **08**

References

1. Mary Ann Curran “Environmental Life-Cycle Assessment” McGraw Hill, 1996.
2. Ian Lerche& Walter Glaesser “Environmental Risk Assessment - Quantitative Measures, Anthropogenic Influences, Human Impact” Springer Heidelberg, 2006.
3. Vincent T. Covello& Miley W. Merkhofer, “Risk Assessment Methods - Approaches for Assessing Health and Environmental Risks”, Springer, 1993.
4. John E. Till & Helen A. Grogan “Radiological Risk Assessment and Environmental Analysis”, Oxford, 2008.

DESIGN AND DRAWING OF ENVIRONMENTAL SYSTEMS – II

Subject Code: EV 67 D **CIE Marks : 50**
Hrs/ Week : 03 **Exam Hours :03**
Exam Marks : 50

Course Objective: The course reinforces the design aspects and drawing skills and capabilities to prepare Engineering drawings of wastewater collection and treatment facility along with air pollution control equipment

Course outcomes Students will be able to:		**Domains (Revised)**
CO1	To draw the layout map of waste water treatment system, labelling the details and prepare typical drawings of different drainage and manhole systems	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	To design (functional only) and draw to scale different primary treatment units	
CO3	Capable of designing and drawing various functional operating units of secondary treatment and knowledgeable enough to draw hydraulic profile of designed units	
CO4	Prepares the designs and drawings related to semi urban and rural sanitation systems	
CO5	Abletopreparetypicaldrawingsofselectedairpollutioncontrolequipmentshowing various component	

COURSE CONTENT

TYPICAL DRAWINGS

Street Inlet, L, V and Box / Trapezoidal Drains, Manhole. Layout drawing of wastewater treatment plant.

DESIGN & DRAWING OF

- Septic Tank, Dispersion Trench and Soak Pit
- Screens and Grit Chamber

- Primary Settling Tank
- Aeration Tank and Secondary Settling Tank
- Trickling Filter and Rotating Biological Contactor (RBC)
- Aerated Lagoon and Stabilization Pond.
- Anaerobic Digester and Sludge Drying Beds
- Hydraulic Profile of Conventional Wastewater Treatment System.

TYPICAL DRAWINGS

Air Pollution Control Systems – Settling Chambers, Bag Filter, and Cyclone Separator

REFERENCES

- Syed.R. Quasim, (1985), **"**Wastewater Treatment Plants – Planning, Design and Operation" – Holt Rinehart and Winston, CBS College Publishing.
- CPHEEO Manual, **"**Sewerage & Sewage Treatment",, Government of India.
- Sincero, A.P., and Sincero, G.A., (1999), **"**Environmental Engineering: A Design Approach" –Prentice Hall of India.
- Wark. K., Warner, and Davis, W.T., (1998), **"**Air Pollution its Origin and Control**",** Addison- Wesley.

ENVIRONMENTAL PROCESS LABORATORY – II

Sub Code : EV 68 L **CIE Marks : 50**
Hrs/ Week : 03 **Exam Hours : 03**
Exam Marks : 50

Course Objective: The lab course provides an opportunity to collect, preserve, characterize wastewater and industrial wastewater samples using conventional and advanced instruments, and perform bench scale treatability studies.		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	To acquaint with the standard procedure or conducting collection, preservation and characterization of wastewater and industrial wastewater samples	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	To evaluate the performance efficiency of various wastewater treatment processes– filtration, RO, adsorption experiments with isotherms and break through curve, and perform various characterization test on sludge	
CO3	To develop the ability to analyse, interpret and infer the laboratory data and to know the application of advanced equipment and hands- on practice–GC, ICP, HPLC & UV–VIS spectrophotometer.	

COURSE CONTENT

1. Domestic Wastewater Characterization
2. Industrial wastewater Characterization
3. Adsorption Experiments
4. Coagulation and Flocculation Experiments
5. Wastewater Polishing Units - Water Hyacinth and Duckweeds
6. Bench Scale Experiments – Aeration, Trickling Filter and Rotating Biological Contactor.
7. Sludge Analysis – VSS, VFA, Nitrates & Phosphates, pH, Settleability, filterability using Buchner funnel Tests, Capillary Suction Time Test.

8. Demonstration of Advanced Instruments - GC, HPLC, ICP, TKN, SEM and XRD.

REFERENCES

- American Public Health Association, American Water Works Association, (2012), Standard Methods for Examination of Water and Wastewater, 21st Edition, APHA.
- Adams and Eckenfelder Jr. W.W. (1974), "Environmental, Process Design Techniques for Industrial Waste Treatment", Nashville (USA), 1974.
- Metcalf and Eddy, (2003), "Wastewater Engineering, Treatment and Reuse", 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

ATMOSPHERIC ENVIRONMENTAL ENGINEERING

Sub code: EV 710 **CIE : 50**
Hrs /Week: 04 **Exam Hours: 03**
Exam Marks: 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 Students will be able to:		**Domains (Revised)**
CO1	Understand the importance of composition and structure of atmosphere, sources, classification, effects of air pollutants, measurement of air pollutants and air pollution standards and control regulations	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Able to understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants	
CO3	Prediction of dispersion of air pollutants using Gaussian plume and Box models and to calculate the plume rise using various model equations	
CO4	Understand the basic mechanisms involved, working principles and design aspects of various air pollution controlling equipment	
CO5	Know about sources, standards, measurement, effects and general controlling methods of noise pollution, assessment and control of indoor air quality.	

COURSE CONTENT

Introduction: Composition and Structure of atmosphere, scales of air pollution problem – local, regional and global. Air pollution episodes – Bhopal Gas Tragedy, London and Los Angeles Smog, Sand / Dust Storms **05**

Sources and Classification of Air Pollutants:

Sources of air Pollutants: Natural and Anthropogenic, Units of measurements of air pollutants. Simple problems on unit conversion.
Classification of air Pollutants: Primary and Secondary Pollutants. Photochemical Oxidants, Characteristics, Smoke and its measurement**.** **05**

Effects of Air Pollution

Effect of air pollutants on human, plants and animals, materials and structure/ monuments.
Effects of air pollutants on visibility and other related atmospheric characteristics, Acid rain, Wet Deposition, Greenhouse effect. Global warming. Ozone depletion and Heat island effect**.** **05**

Air Pollution Meteorology

Role of meteorology in air pollution and its control. Meteorological factors – Solar radiation, temperature, lapse rate, wind velocity profile, humidity, precipitation,

Maximum/ Mean mixing depths, atmospheric stability conditions, wind rose diagram.

Inversion – types, plume behaviour under different atmospheric stability conditions, Pasquil – Gifford atmospheric stability classification. Effect of topography on pollutant dispersion. Land/ sea breeze effects, **08**

Atmospheric Dispersion of Stack Emissions

Plume rise, effective stack height, plumerise formulations, guidelines for fixing stack height, problems on plume rise calculations. **06**

Measurement of Air Pollutants

Criteria for station selection, Measurement of various gaseous (CO, HC, NOx, SOx, etc) pollutants, particulate matter and microbial, sampling devices, sampling train, sampling methods/ techniques, stack sampling techniques. **05**

Air Pollution Control Regulations

Air pollution laws/ acts, air quality and emission standards, air pollution indices - determination of air pollution index by different methods. **04**

Air Pollution Control Equipment

General methods, control by process changes
Particulate Matter Control – settling chambers, inertial separators, cyclones, fabric filters, scrubbers, wet collectors, and electrostatic precipitators. Design aspects.
Control of gaseous pollutants – adsorption, absorption, combustion and condensation. **08**

Indoor Air Pollution

Indoor air quality – hospitals, health care facilities, residential and commercial establishments, effects and control, air changes per hour (ACH), IAQ Standards. **04**

TEXT BOOKS

- Wark, K. Warner, C.F. and Davis, W.T.(1980), “Air Pollution its Origin and Control”,Harper& Row Publishers, New York.

- Henry, C. Perkins, (1980), “Air Pollution”,McGraw Hill Co., New Delhi.

REFERENCES

- Boubel, R.W., Donald, L.F, Turner, D.B. and Stern, A.C.(1994),”Fundamentals of Air Pollution” Academic Press, New York.
- Crawford, M. (1980), “Air pollution Control Theory”, THM Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Noel De Nevers, (2000), “Air Pollution Control Engineering”, International Edition. McGraw Hill International
- Sincero, A.P. and Sincero, G.A. (1999), “Environmental Engineering – A Design Approach**”** Prentice Hall of India, New Delhi.
- Emission Regulations 1, 2, 3, CPCB.

INDUSTRIAL WASTEWATER TREATMENT TECHNOLOGIES

Subject Code: EV 720 **CIE : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course provides a strong base of different industrial waste processes, effluent flow and characteristics, approaches to waste minimization, strength and volume reduction. Also, exposes the student to the areas of toxicity and treatability studies. Makes the student to understand the need for process flowsheets with waste streams of different industries.

Course outcomes Students will be able to:		**Domains (Revised)**
CO1	Able to quantify pollution load and decides on the need for combined wastewater treatment system.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Understands strength and volume reduction, waste minimization processes Develops knowledge on bio-monitoring and its protocol.	
CO3	Able to perform bench-scale as well as pilot scale treatability studies, establishes bio-kinetic coefficients for designing real time treatment facilities.	
CO4	Able to draw process and treatment flow schemes for selected industries and builds up qualitative data on the characteristics of each process effluent.	
CO5	Get information on recent developments in waste minimization approaches including zero discharge concept and 3-R concepts.	

COURSE CONTENT

Introduction: Inventory of Industrial Wastewaters. Industrial waste survey. Flow Diagrams for potential waste stream identification and need for segregated line of

treatment. Discharge guidelines and Standards. **06**

Variations in Flow and Concentration: Monitoring and mass load calculations. **04**

Combined Treatment: Raw Industrial Wastes and Domestic Wastewater after mixing partially or fully. Selection of Treatment Methods. **06**

Approaches to Waste Minimization - Equalization, Neutralization, Volume Reduction, Strength Reduction and Proportioning. **06**

Toxicity: Toxicity assays**,** Biomonitoring of Effluents, Toxicity tests– protocols, test organisms, priority metals – their toxicity levels, decontamination/detoxification of toxic waste streams. **08**

Treatability Studies: Bench-scale studies and its input to pilot scale studies leading to real scale implementation. Determination of kinetic coefficients**.** **06**

Process Flow Schemes and Characteristics: Red, Orange, White and Green categories of industries**.** Effects and Treatment of Industrial Wastes from - Sugar &Distilleries, Pulp & Paper, Pharmaceuticals, Tanneries, Food processing, Textile, Fertilizer, Steel & Dairy Industries. **08**

3R APPROACH – need, wastewater reduction, reuse, and recycle applications, zero discharge concept.

Sludge handling and disposal. **06**

TEXT BOOKS

- Nemerow, N.L., (1982), " Liquid Waste of Industry- Theories, Practice and Treatment", Addison Wesley
- Rao, M.N., and Datta, A.K., (1987), " Wastewater Treatment", Oxford and IBM Publishers

REFERENCES

- Mahajan, S.P., (1987), **"**Pollution Control in Process industry**"**, TMH Co.

- Metcalf and Eddy inc, (2003): " Wastewater Engineering, Treatment and Reuse" , 4TH Edition, Tata McGraw Hill Publishing Co., Ltd.,

ENVIRONMENTAL IMPACT ASSESSMENT

Sub Code : EV 730 **CIE Marks : 50**
Credits : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The student expands his knowledge with the understanding of the need for impact assessment, assessment tools and methods, environmental attributes, importance of public participation and with a sound knowledge of case studies

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to appreciate the need for impact analysis of developmental activities on environmental systems by performing EIA process through understanding the purpose, scope and hierarchical aspects	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Describes the role and necessity of EMP and DMP and learns various Techniques of conducting EIA	
CO3	Considers and evaluates the impact on environmental attributes of concern due to developmental projects	
CO4	Have an understanding of public participation, its framework and describes EIA audit procedure	
CO5	Develops ability to apply the knowledge of EIA to various developmental activities	

Introduction - Definition, Purpose and Scope of EIA, Types of EIA. Evolution of EIA in India and other countries. The EIA process. Procedural and methodological Limitations of EIA. **04**

Guidelines and Regulations – EPA, EIA Notification of 2006 and subsequent amendments, terms of reference – Standard and additional for EIA/EMP report for projects/activities, MoEF&CC guidelines on siting of industries, ecologically sensitive areas, NABET accreditation for EIA consultants, Role of National Green Tribunal in EIA.

09

Methodologies & Techniques in EIA - Adhoc, checklist, matrix, overlays, networks, BEES, Cost-Benefit-Analysis (CBA), brain storming, fuzzy, Delphi technique, Simulation models **08**

Contents of EIA – structure of EIA, Environmental Management Plan (EMP) and Disaster Management Plan (DMP). **03**

Environmental Attributes - Air, water, land, sound, Socio economic aspects, biodiversity. **05**

Public participation in EIA - Need, objectives, elements and framework for public participation – step by step procedure. **03**

Post EIA activities **03**

EIA audit –Types and auditing procedure **05**

EIA case studies – Category A, B1 and B2 **10**

TEXT BOOKS

- Rau and Wooten, (1981), “Environmental Impact Assessment” Handbook.
- Jain R.K., Urban L.V., Stacey G.S., (1977), “Environmental Impact Analysis – A New Dimension in Decision Making", Van Nostrand Reinhold Co.

REFERENCES

- Clark B.C. Bisett and Tomlinsan P, (1985), “Perspective on Environmental Impact Assessment”, Allied Publishers.
- Canter L., (1995), “Environmental Impact Assessment”, McGraw Hill.
- Journals - Science Direct, acs.org.
- EIA notifications and Publications, MoEF&CC, GoI

ENVIRONMENTAL STATISTICS – METHODS & APPLICATIONS

(ELECTIVE II)

Subject Code : EV 741 **CIE : 50**
Hours / Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The student will have an overall understanding of statistics, types, and applications for effective management of environmental data. It covers a wide range of statistical aspects including data characteristics and grouping, correlation & regression, probability, testing hypotheses and timeseries analysis		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student outlines different forms of data, characteristics of data and its grouping, frequency analysis.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Able to learn skewness of the data, moving average and weighted mean concepts	
CO3	Ability to analyse data distribution using random and non-random sampling, variance, probability and probability distribution	
CO4	Able to calculate different types of correlation coefficients for a given set of data using linear, non-linear and multiple regression techniques	
CO5	Understands clearly the time series analysis of data to establish trend and seasonal variations and uses methods of testing hypotheses	

COURSE CONTENT

Introduction; Sample and Population; Discrete and Continuous; Collection, Arranging and Presentation of data; Sturge's rule; Frequency grouping; Frequency and relative frequency distribution; Cumulative frequency; Frequency polygon; Ogives; Problems. **07**

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. **07**

Characteristics of Distributions: Dispersion – Range; Interquartile Range; Variance; Standard Deviation (Population & Sample); Bessel's correction; Mean Deviation; Coefficient of Variation; Problems. **06**

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. **06**

Sampling and Sampling Distributions: Types – nonrandom and random; Biased samples; Random sampling; Systematic sampling; Stratified sampling; Cluster sampling; **06**

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; **07**

Time Series; Problems. **04**

Testing Hypotheses: Concepts basics; Null hypothesis; Level of Significance; Degrees of Freedom; Hypothesis testing of Means; Chi-Squared test; F distribution; Students t-test; Analysis of Variance – within samples and between samples; Problems. **07**

TEXT BOOKS

- Adam M. Neville and John B. Kennedy, (1966), "Basic Statistical Methods for Engineers and Scientists", 2nd Edition, IEP

- Richard I. Levin and David S. Rubin, "Statistics for Management" (1998), 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.

ENVIRONMENTAL ECONOMICS, LEGISLATION AND FORENSICS
(ELECTIVE III)

Subject Code : EV 742 **CIE : 50**
Hours / Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course provides a solid foundation on basics of environmental economics, its necessity, establishes a strong link between environment and economics. Understands the social and economic costs, valuation techniques and their application. It also covers environmental policy, acts, rules and regulations for effective pollution prevention and control.

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to relate the impact of externalities on natural resources and defines social cost functions	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Understands the economics of exhaustible and non-exhaustible resources, appreciates the need for common pool of resources. Also gets familiarized with the valuation techniques for measuring tangible and intangible benefits	
CO3	Able to relate sustainability and development for resource planning and conservation	
CO4	Capable of describing and understanding the national environmental policy, goals and procedural aspects. Knows in detail the environmental acts ,rules, regulations and amendments for the betterment of the society	
CO5	Gains in-depth knowledge on various acts related to environment and applies the same for effective use, conservation of natural resources and concepts of Environmental Forensics.	

COURSE CONTENT

Environmental Economics

Introduction to Environmental Economics **02**
Externalities – Problem of Social Cost and Formal Analysis **06**
Depletion of Non-renewable resources – Economics of Exhaustible resources. **06**
Degradation of commons – The tragedy of commons an Institutional approach for common pool resources (CPR) **04**
Valuation Techniques – Measuring the benefits and costs of pollution control, contingency valuation and economics **06**
Sustainability – Economics perspective, Environmental Accounting – an operational perspective **04**

Development and Environment -Poverty and environmental resource base, economics of the green house effect.
Microeconomic theory - production or consumption involves externalities, and environmental benefits, Emissions and welfare, Sustainable resource use and economics, Macroeconomic implications for the promotion of environmentally-friendly products. **04**

Environmental Legislation

Environmental Policy, Legal frame work for environmental protection.
Need, Constitution of India, Environmental Jurisprudence, Environmental Acts, Rules and Regulations, Amendments. **06**

Indian Environmental Acts – Environment (Protection) Act, 1986, Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, The Forest Conservation Act, 1980, Wild Life Protection Act, 1972, Biodiversity Rules, 2004, import of genetically engineered microorganisms, manufacture, storage, import of hazardous chemical rules, 1989, The National Green Tribunal Act, 2010, Coastal Regulation Zone Notification, E - Waste (Management and Handling) Rules, 2011, Batteries (Management & Handling) Rules, 2001, Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008, Municipal Solid Wastes (Management and Handling) Rules, 2000. **08**

ENVIRONMENTAL FORENSICS:
Pollutant Policing: basic aspects, EF past present and future. Measurements of parameters, baselines and value functions, finger printing tools and techniques. Statistical interpretation of data. Indices and markers. Pollutants transport models - pathway tracing. Case studies and EF legislation. Futuristic emerging forensics for pollution prevention – time frames and solutions **04**

TEXT BOOKS

- Ulaganathan Sankar, (2001), “Environmental Economics”, Oxford University Press, UK
- CPR Environmental Education Centre, (2006), “Environmental Laws of India – An Introduction”, CPR Publications

REFERENCES

- Ramprasad Sengupta, (2013), “Ecological Limits and Economic Development”, Oxford University Press
- Bhattacharya R.N., (2001), “Environmental Economics – An Indian Perspective”, Oxford University Press

REACTOR DESIGN AND TECHNOLOGY
(ELECTIVE II)

Subject Code: EV 743 **CIE Marks : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course emphasizes mainly on the different types of reactions and reactors, fundamentals of reactor design for isothermal and non-isothermal, homogeneous and heterogeneous ,as well as fixed-bed and fluidized-bed reactors		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Understand different types of reactions, reactors and their analysis and scale-up of laboratory bench scale reactors	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Able to understand the design aspects of reactors using mass balance approach, conservation of mass in reactors and the influencing parameters which affect the efficiency of the reactor	
CO3	Know the design criteria for batch, semi and continuous reactors under isothermal and non-isothermal conditions, along with their rate equations	
CO4	Able to understand the structure of the laboratory scale reactors under homogenous and heterogeneous conditions	
CO5	Knowledge to design fixed bed as well as fluidized bed reactors and their selection for treating the wastewaters.	

COURSE CONTENT

Chemical Kinetics: types of reactions, reaction order, rate of reaction, types of reactors, reactors' analysis, Scale up designs **12**

Design Fundamentals – Mass Balance approach, Conservation of Mass in reactors, Influencing parameters **08**

Isothermal and Non-isothermal Reactors – Design criteria, batch, semi and continuous systems and rate equations **10**

Laboratory Reactors – Homogeneous and Heterogeneous Reactors, Structure of Reactors **10**

Design of Fixed Bed and Fluidized Reactors **10**

TEXT BOOKS

- Bailey J.E., and Ollis D.F., (1986), “Biochemical Engineering Fundamentals”, McGraw Hill International

- Himmelblau D.M., (1999), “Basic Principles and Calculations in Chemical Engineering”, PHI, New Delhi

REFERENCES

- Smith J.M., (1984), “Chemical Engineeting Kinetics”, 3rd Edition, McGraw Hill International

- Kutepor A.M., Bondareva T.I., and Berengarten M.G., (1988), “Basic Chemical Engineering with Practical Applications”, Mir Publishers, Moscow

- Geonkoplis C.J., (1999), “Transport Processes and Unit Operations”, PHI, New Delhi

ATMOSPHERIC AND ENVIRONMENTAL SYSTEMS SOFTWARE LABORATORY

Sub Code : EV 75 L **CIE : 50**
Hrs/ Week : 03 **Exam Hours : 03**
Exam Marks : 50

Course Objective: The lab course focuses on atmospheric processes, sampling, monitoring and data interpretation of air pollutants and noise measurements. The lab course also discusses about executing environmental Engineering related softwares.		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to carry out different monitoring tests on ambient air quality parameters – gaseous pollutants and vehicle exhaust emissions	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Capable of developing wind rose diagrams, noise measurements and interpretation and measurement of light intensity for different applications. Gets a fair knowledge of stack monitoring and various air pollution control equipment through demonstration.	
CO3	Capable of writing and executing programmes related to statistical analysis, population forecasting and water and wastewater systems and prediction of air pollutant dispersion using air quality dispersion models.	

AIR POLLUTION MONITORING

1. Introduction to Atmospheric Monitoring: Particulate Sampling – Dust Fall, Pollution, Particulate Matter - PM10, PM2.5 using High Volume Air Sampler (H.V.A.S.).
2. Estimating Sulphur oxides and nitrogen oxides in ambient air using H.V.A.S.
3. Monitoring and identification of air borne microbes
4. Exercises on auto exhaust analyzer for Petrol Vehicles.
5. Exercises on noise measuring instruments.
6. Exercises on Lux-meter (Light Intensity measuring Instrument)
7. Windrose Diagrams - Wind Monitoring and Analysis of Data
8. Stack Sampling Techniques and Demonstration of Stack Monitoring.
9. Exercises on Ambient Gas Monitoring using GASTEC Device.

ENVIRONMENTAL SYSTEM SOFTWARE

To execute the softwares of : Population forecast, rising main design, LOOP water distribution design, Sewer design, WATPLANT, ISCST3 Air pollutant dispersion model and KALINE model.

REFERENCES

- 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
- Crawford M, (1976), “Air Pollution Control Theory”, TMH Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi

TRANSPORT AND FATE OF ENVIRONMENTAL POLLUTANTS

Sub code: EV 810 **CIE : 50**
Hrs /Week: 04 **Exam Hours: 03**
Exam Marks: 100

Course Objective: Student builds an understanding and applicational knowledge on various physical phenomena, chemical and biological processes and their influence on the fate and transport of a variety of pollutants in water, soil and air compartments.

Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student understands the fundamentals of mass balance approach and process dynamics.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Learns the physical phenomena–advection, convection and evaporation processes and able to derive related equations with analytical solutions.	
CO3	Able to describe the concept of mixing zone in natural aquatic bodies and its influence on pollutant dispersion.Derives2-DStreeter-Phelps'sequation and uses it to solve simple numerical problems.	
CO4	Differentiates stratified and unstratified lake systems, develops knowledge on dispersion characteristics of pollutants in lakes, estuaries, and ocean environment.	
CO5	Acquires sufficient knowledge to derive1 and 2 D equations for pollutant dispersion in sub-surface soil. Applies effectively the Gaussian distribution model to plot ground level concentrations of air pollutants for dynamic meteorological conditions.	

COURSE CONTENT

Introduction to Modelling and Transport Processes, Process Dynamics, Mass Balance Approach, Material Balance Relationship. **06**

Mechanics of Mass Transport: Diffusive and Convective Mass Transport. Fick's Law of Diffusion, Combined Convective-Diffusion Equations for 1 and 2 Dimensions. Analytical Solutions for 1-D & 2-D Cases, Simple Problems. **14**

Principal Components of DO analysis, Sources and Sinks of DO, Effects of Oxygen Demanding Waste, Bacteria and Nutrients, Streeter –Phelp's Equation and Expression for Critical Point, 2-D models, Mixing zone concept – types of outfall and mixing regimes, Simple Problems. **10**

Description of Water Quality Processes in Natural Water Bodies: Lake (stratified and completely mixed), Estuary and Coastal Regions. **10**

Groundwater Quality: Basic differential equations with analytical solutions for 1-D case. **04**

Air quality modelling: Gaussian plume model – for point source. Gaussian dispersion co-efficient, Downwind ground-level concentration computation, maximum ground level concentration. **06**

TEXT BOOKS

- Schnoor J.L., (1997), "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.
- Thomann R.V., & Mueller M. J., (1987), "Principles of Water Quality Modelling and Control", Harper & Row Publishers.
- Metcalf & Eddy Inc, (2003), "Wastewater Engineering, Treatment and Reuse"- 3rd Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi.

REFERENCES

- Freeze R.A. and Cherry J.A., (1979), "Groundwater", Prentice Hall, New Jersey
- Weber W.J., (1972), "Physico - Chemical Processes for Water Quality", John Wiley & Sons,
- Fischer H. B., List E.J., Koh R.C.Y., Imberger J., Brooks N.H., (1979), "Mixing in Inland and Coastal Waters", Academic Press Inc.

ENVIRONMENTAL ENGINEERING MANAGEMENT PRACTICES

Subject Code: EV 820 **CIE : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: This course enhances leadership qualities through communication and managerial skills in the student with a refined knowledge on proactive management issues, human resources management, analytical skills for effective project formulation and implementation. The course also invokes creative thinking on newer pollution prevention mechanisms through collaborative research		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	The student clearly distinguishes between reactive and proactive management, able to correlate between environment and economy and understands the need for organizational structure for effective environmental management	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Develop ability to define functions and identifies types and levels of management, develops SWOT /SWOC for improved management style	
CO3	Builds the base for efficient personnel management by acquiring skills like time management, interactive leadership style, human relationship	
CO4	Able to appreciate the project formulation, applies CPM & PERT for good decision making. Capable of planning appropriately using carrying capacity concept	
CO5	Imbibes excellent communicating skill, understands the role of non-profit organizations and media in environmental management.	

COURSE CONTENT

Introduction: Proactive and Reactive environmental management. Environment and economy – excludability and rivalry. Continuous and continual improvement. Organizational structure for Environmental Management at central and state levels. Environmental audits. **08**

Management Basics & Strategies: Definitions of management, Functions of management - classification, coordination, Types and levels of management, TOWS matrix, TQM and environmental protection, ISO 14000 and 18000 series of Standards. **08**

Personnel management: Motivation–importance, need theory-Moslow, pre-requisites. Time and man management, factors of production and entrepreneurship. Employee-employer relationship, leadership styles and situational model, leadership qualities. Communication – elements and objectives, characteristics, barriers, (verbal &non

verbal), downward & upward, factors and soft skills. **08**

Project formulation: Bar chart & milestone charts, programme evaluation & review technique (PERT) & time estimates, Critical path method (CPM) and scheduling, decision matrix – problems. **08**

Cleaner technologies: Cleaner production and prevention of pollution in small businesses, CT and their role in environmental management: limitations. Incorporating cleaner production in to EIA. Life cycle assessment in to process, zero emissions-the ultimate goal of cleaner production. CP in select red category industries – mining, breweries, pulp and paper mills. **08**

Environmental communication: Role of institutions, (NGOs, GOs, educational institutions), role of public, media. **06**

Environmental Research: Need, areas of research, applied and advanced research, premier research organizations. **04**

TEXT BOOKS

- Lohani, B. N., (1984), "Environmental Quality Management" - South Asian Publishers, New Delhi.,
- Schermerhorn J.R., (2010), "Introduction to Management", Tenth Edition, International Student Version, John Wiley and Sons Inc., UK
- Richard Welford, (1999), "Corporate Environmental Management", Universities Press.

REFERENCES

- Suresh, K. and Dhameja, (2000), " Environmental Engineering and Management" , S.K. Kataria and Sons
- Peurifoy, R. L., (1979), "Construction Planning Equipment and Methods", McGraw Hill.
- Banga, and Sharma, (2007), "Industrial Organization and Engineering Economics", Khanna Publishers.

NATURAL RESOURCES CONSERVATION AND MANAGEMENT
(ELECTIVE III)

Subject Code: EV 831 **CIE: 50**
Hours / Week: 4 **Exam Hours: 03**
Exam Marks: 100

Course Objective: This unique course gives the student the feel and understanding of natural resources availability, their use and abuse, need for conservation. It equips the student with a thorough understanding of biodiversity, planning and legislation for effective resource management.		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Able to classify natural resources, identifies the threats and comprehends the flow of resources in nature.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Enhances thinking capability on issues such as resource allocation, use and pollution problems of forests, water, and abiotic components of natural resources.	
CO3	Outlines the importance of food security, modern agricultural practices, use and impact of chemical fertilizers and pesticides .Able to estimate and identify food production and its problems related to storage, transport and allocation.	
CO4	Capable of determining energy demand. Able to understand the energy footprint, crisis in energy production, impacts of fossil fuel burning. Develops knowledge on alternate energy sources for sustainable development.	
CO5	Understands symbiotic and synergic relationships of different ecosystems. Appreciates the need for conserving biodiversity and identifies possible threats. Able to list and appreciate the ecological importance of major biodiversity hot-spots. Capable of applying the knowledge of environmental legislation for resource management.	

COURSE CONTENT

Natural resources

Classification, Resources Appraisal, Resource problem, Renewable resources flow, destruction versus conservation **06**

Forest Resources

Uses, Ecological and economic significance, types and management, forest resources of the world and India, deforestation and its impact and solution **06**

Water Resources

Hydrologic cycle, global and national water resources, demand and distribution, Classification of surface water bodies for designated best usage. Management of water

resources, Environmental Impact of large dams, River water disputes, water pollution problems. **06**

Mineral Resources
Exploration, causes for depletion, environmental impacts and conservation measures. **04**

Food Resources
World food production and problems, food security, agri production, live stock production, modern agri practices, use of pesticides and fertilizers – environmental impact, environmental limits of increasing food production, sustainable agriculture **06**

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) **06**

Land Resources
Land as a resource, soils – types and degradation- soil erosion and pollution, soil conservation **04**

Biodiversity Resources
Genetic and species diversity, Ecosystem diversity, types of ecosystems- structure and function, symbiotic and synergic relationship, 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 **04**

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

CLIMATE CHANGE AND EMISSION TRADING
(ELECTIVE III)

Subject Code: EV 832 **CIE : 50**
Hrs/ Week : 04 **Exam Hours : 03**
Exam Marks : 100

Course Objective: The course outlines higher level concepts of drivers of climate change, impacts and sectorial climate models. Exposes the student to various facets of vulnerability and adaptability, possible mitigative measures. Introduces Indian climate change scenario. Also covers the importance of emission trading, trading mechanisms, regulatory framework and market potential		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Gets a feel of history of climate change and able to identify the major drivers of climate change. Knows the climate change models and their application in different sectors	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Comprehends the impacts of climate change on various sectors. Able to assess vulnerability	
CO3	Able to assess impacts of climate change on various sectors in India and device appropriate mitigation measures	
CO4	Describes spatial dimension of emission trading, its pros and cons. Understands intricacies of emission trading mechanisms and implementation	
CO5	Gets an awareness on market feel and potential of emission trading along with monitoring and enforcement framework.	

COURSE CONTENT

Introduction: Earth's climate, climate change, drivers of climate change **04**
Climate models: Models for climate change, GCMs, RCMs, designing climate change experiments with climate models, climate change scenarios
Sector models – water resources, Agricultural, forestry, energy. **10**
Climate change impacts: Impacts of climate change on environment, human, agriculture and energy systems, coastal zone**.** **06**
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 **04**
Climate change and India, impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India; mandatory requirements for project financing**.** **04**

Emission trading
Introduction to emission trading, evolution of emission trading and design features

Cost-effective permit markets, the role of transaction costs, the role of technical change, Consequences of emission trading **04**

The spatial dimensions: difficulties in implementing an ambient permit system, possible alternatives, nature of evidence, borrowing, banking, and environmental target, Linking emissions and pollutant concentrations. Strategies for controlling seasonal or episodic peaks and allocation approaches **06**

Market power: permit price manipulation, conceptual models, leveraging power between output and permit markets, mechanisms for controlling market power, programmatic design features that affect market power**.** **04**

Monitoring and enforcement:

Domestic and international enforcement process, economic enforcement, current enforcement practice, program effectiveness **04**

TEXT BOOKS

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

REFERENCES

- UNFCCC Reports on Climate Change.
- Thomas H. Tietenberg ,(2006), "Emissions Trading: Principles and Practice", 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

EQUIPMENTS, INSTRUMENTATION AND AUTOMATION IN ENVIRONMENTAL ENGINEERING
(ELECTIVE III)

Sub Code :EV - 883 **IA Marks : 25**

Hrs/ Week : 04 **Exam Hours : 03**

Total Hrs. : 52 **Exam Marks : 100**

Course Objective: The Course will expose the student to various facets of analytical instruments to be used in analyzing organic and inorganic present in water, wastewater and air samples and also to understand the automated water/ wastewater treatment processes (SCADA)		
Course outcomes **Students will be able to:**		**Domains (Revised)**
CO1	Discuss the method of analysis of colour and single component organics present in water and wastewater.	1) Remember 2) Understand 3) Apply 4) Analyze
CO2	Explain the method of analysis of sodium and potassium present in soil and water samples.	
CO3	Apply the knowledge of usage of mass spectrometer in the analysis of various parameters such as heavy metal ions, inorganic present in water and wastewater samples and also to explain the SCADA system to understand the automated water and wastewater treatment processes.	
CO4	Explain the method of analysis of various end products of aerobic/ anaerobic digestion process.	
CO5	Describe the determination of density of liquid/ gaseous samples and to know the measurement of pCO_2 and pO_2 present in different phases of medium.	

COURSE CONTENT

Visible Ultraviolet spectrophotometers: Electromagnetic radiation, Beer Lambert law, absorption instruments, colorimeters, spectrophotometers, infrared spectroscopy theory, instrument and its types. **06**

Flame photometers: Principle of flame photometers constructional details of flame photometers, accessories of flame photometers, interference in flame photometry and determinations. **07**

Fluorimeters & Phosphorimeters: Principle of fluorescence, measurement of fluorescence, spectro fluorescence, Measurement of Phosphorescence. **06**

Mass spectrometer: Basic concept, types of mass spectrometer, components **07**

of mass spectrometer, resolution and applications.

Automated bio-chemical analysis systems: Basic concepts, system details, system components, typical multiple analysis system, flow injection analysis. SCADA in water and wastewater system. **06**

Chromatography: Gas chromatography –basic concepts, parts of gas chromatography. Method of peak areas, liquid chromatography – basic concepts, types if liquid chromatography, the liquid chromatograph. **07**

Electrophoresis and densitometers: Basic Electrophoresis, Electrophoresis technique, paper Electrophoresis, Electrophoresis apparatus, spectrodensitometer, microprocessor based densitometer, microelectrophoresis. **07**

Gas analyser: Principle of pH measurement, pCO_2 and pO_2 measurement in Automatic exhaust gas analyser. **06**

TEXT BOOK:

1. Hand book of analytical Instruments by R. S. Khandpur, TMH publication 1st Ed 1989, New Delhi.

REFERENCE BOOKS:

1. Instrumental methods of analysis by H. H Willard, L. L. Merritt & J. A. Dean, CBS Publications 7th Ed 1988.

2. Principles of Instrumental analysis by S. J. Holler & T. A. Nilman Saunders college Publications 5th Ed 1998.