AFFILIATED INSTITUTIONS

ANNA UNIVERSITY, CHENNAI

REGULATIONS 2009

M.E. ENVIRONMENTAL ENGINEERING

II TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER II

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	EN9321	Solid and Hazardous Waste Management	3	0	0	3
2	EN9322	Physical and Chemical Treatment of Water and Wastewater	3	0	0	3
3	EN9323	Biological Treatment of Wastewater	3	0	0	3
4	EN9324	Industrial Wastewater Management	3	0	0	3
5	EN9325	Environmental Impact Assessment	3	0	0	3
6	E1***	Elective I	3	0	0	3
7	E2***	Elective II	3	0	0	3
		TOTAL	**21**	**0**	**0**	**21**

SEMESTER III

S.No.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	E3***	Elective III	3	0	0	3
2	E4***	Elective IV	3	0	0	3
3	E5***	Elective V	3	0	0	3
PRACTICAL						
4	EN9331	Project Work (Phase I)	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
PRACTICAL						
1	EN9341	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

Total Credits to be Earned for the Award of the Degree = 66

LIST OF ELECTIVES

S.NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1	EN9001	Environmental Quality Modeling	3	0	0	3
2	EN9002	Instrumental Monitoring of Environment	3	0	0	3
3	EN9003	Remote Sensing and GIS for Environmental Applications	3	0	0	3
4	EN9004	Ecological Engineering	3	0	0	3
5	EN9005	Ground Water Contamination and Transport Modelling	3	0	0	3
6	EN9006	Environmental Biotechnology	3	0	0	3
7	ES9014	Indoor Air Quality	3	0	0	3
8	EN9008	Environmental Policies and Legislation	3	0	0	3
9	EN9009	Environmental Engineering Structures	3	0	0	3
10	EN9010	Mass Transfer In Air-Water Soil Interaction	3	0	0	3
11	EN9011	Marine Pollution Monitoring	3	0	0	3
12	ES9326	Unit Operations and Processes Laboratory	0	0	4	2

EN9321 **SOLID AND HAZARDOUS WASTE MANAGEMENT**

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Types and sources of solid and hazardous wastes – Need for solid and hazardous waste management – Elements of integrated waste management and roles of stakeholders – Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, plastics and fly ash.

UNIT II WASTE CHARACTERISATION AND SOURCE REDUCTION **6**

Waste generation rates and variation – Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – Waste sampling and characterization plan – Source reduction of wastes – Recycling and reuse – Waste exchange.

UNIT III STORAGE, COLLECTION AND TRANSPORT OF WASTES **9**

Handling and segregation of wastes at source – Storage and collection of municipal solid wastes – Analysis of collection systems – Need for transfer and transport – Transfer stations Optimizing waste allocation – Compatibility, storage, labeling and handling of hazardous wastes – Hazardous waste manifests and transport.

UNIT IV WASTE PROCESSING TECHNOLOGIES **12**

Objectives of waste processing – Material separation and processing technologies – Biological and chemical conversion technologies – Methods and controls of composting – Thermal conversion technologies and energy recovery – Incineration – Solidification and stabilization of hazardous wastes – Treatment of biomedical wastes.

UNIT V WASTE DISPOSAL **9**

Waste disposal options – Disposal in landfills – Landfill Classification, Types and methods – Site selection – Design and operation of sanitary landfills, secure landfills and landfill bioreactors – Leachate and landfill gas management – Landfill closure and environmental monitoring – Closure of landfills – Landfill remediation .

TOTAL: 45 PERIODS

REFERENCES:

1 George Tchobanoglous, Hilary Theisen and Samuel A.Vigil, “Integrated Solid Waste Management”, McGraw- Hill International Edition, 1993.

2 CPHEEO “Manual on Municipal Solid Waste Management”, Central Public Health and Environmental Engineering Organisation, 2000.

3 Micheael D. Algeria, Philip L Buckingham and Jeffrey C. E. Vans, “Environmental Resources Management, Hazardous waste Management”, McGraw-Hill International Edition, 2001.

4 Vesilind P.A., Worrell W and Reinhart, “Solid Waste Engineering”, Thomson Learning Inc., 2002.

EN9322	PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTEWATER	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 3

Pollutants in water and wastewater – Characteristics – Standards for performance – Significance and need for physico-chemical treatment.

UNIT II PHYSICAL TREATMENT PRINCIPLES 10

Principles of Screening – Mixing, equalisation – Sedimendation – Filtration – Modelling – Back washing – Evaporation – Incineration – Gas transfer – Mass transfer coefficients – Adsorption – Isotherms – Principles, equilibria and kinetics, reactors, regeneration, membrane separation, Reverse Osmosis, nano filtration ultra filtration and hyper filtration – Electrodialysis, distillation – Stripping and crystallization – Recent Advances.

UNIT III CHEMICAL TREATMENT PRINCIPLES 9

Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation, solidification and stabilization – Disinfection – Ion exchange, Electrolytic methods, Solvent extraction – advance oxidation /reduction – Recent Advances.

UNIT IV DESIGN OF CONVENTIONAL TREATMENT PLANTS 15

Selection of unit operations and processes – Design of conventional water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – filters – Rapid sand filter, slow sand filter, pressure filter – Chlorinators – Displacement and gaseous type. Layouts – flow charts – Hydraulic Profile – O and M aspects – Case studies – Residue management – Upgradation of existing plants – Recent Advances.

UNIT V DESIGN OF INDUSTRIAL WATER TREATMENT AND RECLAMATION 8

Selection of process – Design of softeners – Demineralisers – Wastewater reclamation – Reverse osmosis plants – Residue management – O and M aspects – Recent Advances – Case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Metcalf and Eddy, “Wastewater Engineering, Treatment and Reuse”, Tata McGraw-Hill, 2003.
2. “Manual on Water Supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, 1999.
3. Lee, C.C. and Shun dar Lin, “Handbook of Environmental Engineering Calculations”, McGraw-Hill, 1999.
4. Qasim, S.R., Motley, E.M. and Zhu, G., “Water works Engineering – Planning, Design and Operation”, Prentice Hall, 2002.
5. Casey, T.J., “Unit Treatment Processes in Water and Wastewater Engineering”, John Wiley and Sons, 1993.

EN9323 BIOLOGICAL TREATMENT OF WASTEWATER

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 10

Objectives of biological treatment – Significance – Aerobic and anaerobic treatment - Kinetics of biological growth – Factors affecting growth -attached and suspended growth – Determination of kinetics coefficients for organics removal – Biodegradability assessment – Selection of process.

UNIT II AEROBIC TREATMENT OF WASTEWATER 10

Design of sewage treatment plant units – Screen chamber – Grit chamber with proportional flow weir, sedimentation tank – Trickling filters – Rotating biological contactor, activated sludge process and variations, aerated lagoons, waste stabilization ponds – Nutrient removal systems – Natural treatment systems – Disinfected disposal options – Reclamation and reuse – Flow charts, layout, hydraulic profile – Recent advances.

UNIT III ANAEROBIC TREATMENT OF WASTEWATER 10

Attached and suspended growth – Design of units – UASB, up flow filters – Fluidised beds – Septic tank and disposal – Nutrient removal systems – Layout and hydraulic profile – Recent advances.

UNIT IV SLUDGE TREATMENT AND DISPOSAL 5

Design of sludge management facilities – Sludge thickening – Sludge digestion – Biogas generation – Sludge dewatering (mechanical and gravity) – Upgrading existing plants – ultimate residue disposal – Recent Advances.

UNIT V OPERATIONS, MAINTENANCE, MANAGEMENT AND CASE STUDIES 10

Operational problems – Trouble shooting – Planning, organising and controlling of plant operations – Capacity building – Case studies on sewage treatment plants – Sludge management facilities

TOTAL: 45 PERIODS

REFERENCES:

1. Arceivala, S.J., "Wastewater Treatment for Pollution Control, TMH, 1998.
2. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, 999.
3. Metcalf and Eddy, Inc., 'Wastewater Engineering, Treatment and Reuse", 3rd Edition, Tata McGraw-Hill Publishing Company, 2003.
4. Qasim, S.R., "Wastewater Treatment Plant, Planning Design and Operation", Technomic Publications, 1994.

EN9324	INDUSTRIAL WASTE WATER MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 6

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater generation rates, characterization and variables – Population equivalent – Toxicity of industrial effluents and Bioassay tests.

UNIT II INDUSTRIAL POLLUTION PREVENTION 8

Prevention Vs Control of Industrial Pollution – Benefits and Barriers – Source reduction techniques – Waste Audit – Evaluation of pollution prevention options – Environmental statement as a tool for pollution prevention – Waste minimization Circles.

UNIT III INDUSTRIAL WASTEWATER TREATMENT 12

Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT 7

Individual and common effluent treatment plants – Joint treatment of industrial wastewater – Zero effluent discharge systems – Quality requirements for wastewater reuse – Industrial reuse – Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

UNIT V CASE STUDIES 12

Industrial manufacturing process description – Wastewater characteristics – Source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – fertilizers – Thermal Power Plants and Industrial Estates.

TOTAL: 45 PERIODS

REFERENCES:

1. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw-Hill, 1999.
2. Arceivala, S.J., “Wastewater Treatment for Pollution Control”, Tata McGraw-Hill, 1998.
3. Frank Woodard, “Industrial Waste treatment Handbook”, Butterworth Heinemann, 2001.
4. World Bank Group , “Pollution Prevention and Abatement Handbook – Towards Cleaner Production”, World Bank and UNEP,1998.
5. Paul L. Bishop, “Pollution Prevention: Fundamentals and Practice”, McGraw-Hill International, 2000.

EN9325	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 7

Environmental Impact Assessment (EIA) – Environmental impact statement – EIA in project cycle – Legal and regulatory aspects in india according to ministry of environment and forests – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Participation of public and non-governmental organizations in environmental decision making.

UNIT II COMPONENTS AND METHODS 12

Components of EIA – Processes – Screening – Scoping – Setting – Analysis – Mitigation – Matrices – Networks – Checklists – Connections and combinations of processes – Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA.

UNIT III PREDICTION, ASSESSMENT OF IMPACTS AND REPORTING 10

Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – Air – Water – Soil – Noise – Biological – Socio-cultural environments – Cumulative impact assessment – Documentation of EIA findings – Planning – Organization of information and visual display materials – Report preparation.

UNIT IV ENVIRONMENTAL MANAGEMENT PLAN 10

Environmental management plan – Preparation, implementation and review – Mitigation and rehabilitation plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and quality aspects of environmental impact assessment.

UNIT V CASE STUDIES 6

Case studies related to the following sectors – Infrastructure – Mining – Industrial – Thermal Power – River valley and Hydroelectric – Nuclear Power.

TOTAL: 45 PERIODS

REFERENCES:

1. Lawrence, D.P., “Environmental Impact Assessment – Practical solutions to Recurrent Problems”, Wiley-Interscience, 2003.
2. Petts, J., “Handbook of Environmental Impact Assessment”, Vol. I and II, Blackwell Science, 1999.
3. Canter, L.W., “Environmental Impact Assessment”, McGraw-Hill, 1996.
4. Biswas, A.K. and Agarwala, S.B.C., “Environmental Impact Assessment for Developing Countries”, Butterworth Heinemann, 1994.
5. The World Bank Group, “Environmental Assessment Source Book”, Vol. I, II and III, The World Bank, 1991.

EN9001 ENVIRONMENTAL QUALITY MODELLING

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **12**

Basics of mathematical Modeling – Modeling as a tool . Procedures of model development. Importance of model building. Characteristics of deterministic models. Classical approach to constrained and unconstrained optimization. State of the art in environmental engineering systems models – climate and system modeling – Erosion and sediment transport

UNIT II COMPUTER BASED SOLUTIONS **10**

Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models – simulation, parameter estimation and experimental design.

UNIT III WATER QUALITY MODELLING **9**

Rivers and streams water quality modeling-river hydrology and flow-low flow analysis – dispersion and mixing-flow, depth;water quality modeling process-model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens; Groundwater modeling.

UNIT IV AIR QUALITY MODELLING **9**

Air Pollution modeling and prediction, modeling technique, modeling for non reactive pollutants, single source short term impact; multiple sources and area sources, model performance, accuracy and utilization.

UNIT V CASE STUDIES **5**

Software package applications: Air quality modeling and water quality modeling

TOTAL: 45 PERIODS

REFERENCES

1. John Wainwright and Mark Mulligan, “Environmental Modelling Finding Simplicity in Complexity”, John Wiley and sons Ltd, 2004
2. Deaton and Wine brake, “Dynamic Modeling of Environmental Systems” Wiley and Sons, 2002
3. Steven C. Chapra, “Surface Water Quality Modeling”, McGraw-Hill Inc., 1997.
4. Boubel R.W., Fox, D.L., Turner D. B. and Stern, A C., “Fundamentals of Air Pollution, Academic Press, 1994.

EN9002 INSTRUMENTAL MONITORING OF ENVIRONMENT

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **7**

Instrumental methods – Selection of method – Precision and accuracy – Errors in measuring signals – Noise/signal ratio – Base line drift – Indicator tubes.

UNIT II SPECTROSCOPIC METHODS **11**

Electromagnetic radiation – Matter radiation interactions – Colorimetry and spectrophotometry, fluorimetry, nephelometry and turbidimetry, flame photometry – Atomic Absorption Spectrometry (AAS) – Atomic Emission Spectrometry (AES) – Inductively coupled plasma (ICP) – Direct Current Plasma (DCP) spectrometry. ICP – MS (Mass spectrometry).

UNIT III CHROMATOGRAPHIC METHODS 10

Classical methods – Column – Paper – Thin Layer chromatography (TLC), Gas Chromatrography (GC), GC-MS – High performance liquid chromatography (HPLC) and Ion chromatrography (IC).

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS 10

Conductometry, potentiometry, coulometry, amperometry polarography, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS 7

Non-dispersive infra-red (NDIR) analyzer for CO – Chemiluminescent analyzer for NOx – Fluorescent analyzer for SO_2 – Auto analyzer for water quality using flow injection analysis – Permeation devices.

TOTAL: 45 PERIODS

REFERENCES:

1. Willard. H., Merritt, L., Dean, D.A. and Settle. F.A. “Instrumental Methods of Analysis”, 7th Edition, Words Worth, 2004.
2. Ewing, “Instrumental Methods of Chemical Analysis”, 5th Edition., McGraw-Hill, 1995.

EN9003	REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I PRINCIPLES OF ELECTRO MAGNETIC RADIATION 5

Concepts of Remote Sensing – Energy sources and radiation principles, Energy interactions in the atmosphere – Spectral reflectance of earth surface features

UNIT II REMOTE SENSING PLATFORMS 12

Aerial Photographs, Photographic Systems – Visible, Infra Red and Microwave sensing – Active and passive sensors – Satellites and their sensors, Indian Space Programme – Satellite data products

UNIT III DATA PROCESSING 10

Photogrammetry – Satellite data analysis – Visual Interpretation, Interpretation equipments – Digital Image Processing – Image rectification, enhancement, classification, data merging and biophysical modeling – Image Processing software

UNIT IV GEOGRAPHIC INFORMATION SYSTEM 6

Introduction to GIS concepts – Data base structure – Data analysis – GIS software

UNIT V REMOTE SENSING AND GIS APPLICATIONS 12

Management and monitoring of environment, conservation of resources, coastal zone management – Limitations

TOTAL: 45 PERIODS

REFERENCES:

1. Lillesand, T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, 2004.
2. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information Systems", Oxford University Press, 2001.
3. Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company, 1998.

EN9004	ECOLOGICAL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO ECOLOGY AND ECOLOGICAL ENGINEERING 10

Aim, scope and applications of ecology – Development and evolution of ecosystems – Principles and concepts pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems – Productivity in ecosystems – Rationale of ecological engineering and ecotechnology – Classification of ecotechnology – Principles of ecological engineering.

UNIT II SYSTEMS APPROACH IN ECOLOGICAL ENGINEERING 10

Principles – Components and characteristics of Systems – Classification of systems – Structural and functional interactions of environmental systems – Environmental systems as energy systems – Mechanisms of steady – State maintenance in open and closed systems – Modelling and ecotechnology – Elements of Modelling – Modelling procedure – Classification of ecological models – Applications of models in ecotechnology – Ecological economics.

UNIT III ECOLOGICAL ENGINEERING PROCESSES 8

Self-organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.

UNIT IV ECOTECHNOLOGY FOR WASTE TREATMENT 12

Ecosanitation – Principles and operation of soil infiltration systems – Wetlands and ponds – Source separation systems – Aquacultural systems – Agro ecosystems – Detritus based treatment for solid wastes – Applications of ecological engineering for marine systems.

UNIT V CASE STUDIES 5

Case studies of integrated ecological engineering systems and their commercial prospects.

TOTAL: 45 PERIODS

REFERENCES:

1. Kangas, P.C. and Kangas, P., "Ecological Engineering: Principles and Practice. Lewis Publishers", 2003.
2. Etnier, C. and Guterstam, B., "Ecological Engineering for Wastewater Treatment", Lewis Publishers, 1997.
3. White, I.D., Mottershed, D.N. and Harrison, S.J., "Environmental Systems – An Introductory Text", Chapman Hall, 1994.
4. Mitsch, J.W. and Jorgensen, S.E., "Ecological Engineering – An Introduction to Ecotechnology", John Wiley and Sons, 1989.

EN9005 GROUND WATER CONTAMINATION AND TRANSPORT MODELING

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 10

Ground water and the hydrologic cycles – Ground water as a resource – Ground water contamination – Water quality standards – Sources of contamination – Land disposal of solid wastes – Sewage disposal on Land. Ground water and geologic processes. Physical properties and principles – Darcy's Law – Hydraulic Head and Fluid Potential – Piezometers and Nests. Hydraulic conductivity and permeability – Homogeneity and Anisotropy – Porosity and voids Ratio– Unsaturated flow and the water table – Steady state flow and Transient flow – Compressibility and effective stress – Transmissivity and storativity – Equations of Ground water Flow – Limitations of Darcian Approach – Hydro dynamic dispersion.

UNIT II HYDROLOGIC CYCLE AND FLOW NETS 4

Flow nets – Graphical construction – Flow nets by numerical simulation. Steady state Regional Ground Water flow – steady state hydrologic budgets – Fluctuations in ground water levels.

UNIT III RESOURCE EVALUATION 9

Development of Ground Water resources – Exploration for Aquifers – the response of Ideal aquifers to pumping – Measurement of parameters – Laboratory tests – Piezometer test – Pumping tests – Estimation of saturated hydraulic conductivity – Numerical simulation for aquifer yield prediction – Artificial recharge and induced infiltration – Land subsidence – Sea water intrusion.

UNIT IV CHEMICAL PROPERTIES AND PRINCIPLES 9

Constituents – Chemical equilibrium – Association and Dissociation of dissolved species – effects of concentration gradients – Mineral dissolution and solubility – Oxidation and reduction Process – Ion exchange and Adsorption – Environmental isotopes – Field Measurement of Index parameters. Chemical Evolution: Hydro Chemical sequences and facies – graphical methods – Hydro chemical Facies – Ground water in carbonate terrain – Ground Water in crystalline rocks – Ground Water in complex sedimentary systems – Geochemical interpretation of ^{14}C Dates – Process rates and molecular diffusion.

UNIT V SOLUTE TRANSPORT 13

Transport process – non-reactive constituents in homogeneous media and Heterogeneous media – Transport in Fracture media – Hydro chemical behavior of contaminants – Trace metals– Trace nonmetals – Nitrogen, organic substances – Measurement of parameters – Velocity – Dispersivity – chemical partitioning. Modelling Principles – MOC Modelling. Case

TOTAL: 45 PERIODS

REFERENCES:

1. Randall J. Charbeneau, "Ground water Hydraulics and Pollutant Transport", Prentice Hall, Upper Saddle River, 1999.
2. Todd David Keith, "Ground Water Hydrology", 2nd Edition, John Wiley and Sons, 1980
3. Allen Freeze, R. and John A. Cherry, "Ground Water", Prentice Hall, Inc., 1979.

EN9006 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 5

Principles and concepts of environmental biotechnology—usefullness to mankind, current status.

UNIT II DETOXIFICATION OF ENVIRONMENTAL POLLUTANTS 8

Degradation of high concentrated toxic pollutants—halogenated, non-halogenated, petroleum hydrocarbons, metals. Mechanisms of detoxification—oxidation, dehalogenation, biotransformation of metals, biodegradation of solid wastes.

UNIT III MICROBIAL TECHNOLOGY FOR WASTE TREATMENT 12

Biotechnological remedies for environmental pollution—decontamination of groundwater systems, subsurface environment—reclamation concepts—bioremediation. Production of proteins – biofertilizers. Physical, chemical and microbiological factors of composting – health risk – pathogens – odour management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology and applications in agriculture – role of extracellular polymers. Biogas technology – case studies.

UNIT IV RECOMBINANT DNA TECHNOLOGY AND GENETIC APPLICATION 10

Concept of DNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains, radioactive probes, protoplast fusion technology – applications.

UNIT V ETHICAL AND REGULATORY ISSUES 10

Environmental effects and ethics of microbial technology – safety of genetically engineered organisms – microbial containment – Risk assessment, IPR – patents.

TOTAL: 45 PERIODS

REFERENCES:

1. Chaudhury, G.R., 'Biological degradation and Bioremediation of Toxic Chemicals', Dioscorides Press, 1994.
2. Martin.A.M, "Biological Degradation of Wastes", Elsevier Applied Science, 1991.
3. Blaine Metting.F (Jr.,) "Soil Microbiology Ecology", Marcel Dekker Inc., 1993.
4. Wainwright, M., "An Introduction to Environmental Biotechnology", 1999.
5. Old, R.W. and Primrose, S.B., "Principles of Gene Manipulation 3rd Edition, Blackwell Scientific Publications, 1985.

ES9014 INDOOR AIR QUALITY

L	T	P	C
3	0	0	3

AIM:

To educate the students on air pollution and control in the indoor environment

UNIT I INTRODUCTION **7**

Indoor activities of inhabitants -residence time. Levels of many pollutants in indoor and outdoor air. Design and operation of buildings for improvements of public health. IAQ policy issues: sustainability; indoor air quality as a basic human right.

UNIT II INDOOR AIR POLLUTANTS **10**

Air pollutants in indoor environments, private residences, offices, schools, sand public buildings, factors that govern pollutant indoors concentrations, including ventilation. Charateristics, Consequences.

UNIT III CONTROL OF POLLUTANTS **10**

Control of several pollutant classes, such as radon, toxic organic gases, combustion byproducts, and microorganisms such as molds and infectious bacteria. Case study by an exploration of public policy related to indoor air.

UNIT IV CONCEPTS AND TOOLS **8**

Concepts and tools: exposure, material-balance models, statistical models Ventilation

UNIT V INDOOR AIR POLLUTION FROM OUTDOOR SOURCES **10**

Indoor air pollution from outdoor sources: particulate matter and ozone; Combustion byproducts; Radon and its decay products. Volatile organic compounds: odors and sick-building syndrome, Humidity Bio-aerosols: infectious disease transmission. Special indoor environments: A/C units in indoor; museums-labs; Measurement methods, Control technologies, Control strategies.

TOTAL : 45PERIODS

REFERENCES:

1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000
2 Nazaroff W.W and L Alvarez-Cohen, Environmental Engineering Science Wiley sons, New York, 2001.
3. Moroni Marco, Seifet Bernd and Lindrall Thomas, Indoor Air Quality: A Comprehensive Reference Book, Elsvier Science, Vol. 3, 1995

EN9008 ENVIRONMENTAL POLICIES AND LEGISLATION

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **5**

Basics of jurisprudence – Environmental law relation with other disciplines – Criminal law – Common Law – Relevant sections of the Code of Civil Procedure, Criminal Procedure Code – Indian Penal Code.

UNIT II INDIAN CONSTITUTION AND ENVIRONMENT **8**

Introduction – Fundamental Rights – Directive Principles of State Policy – Article 48 (A) and 51-A(g) Judicial enforceability – Constitution and Resources management and pollution control – Indian Forest Policy (1990) – Indian Environmental Policy (1992).

UNIT III ADMINISTRATIVE REGIME and LEGAL REGIME 8

Administrative regulations – constitution of Pollution Control Boards Powers, functions, Accounts, Audit etc. – Formal Justice Delivery mechanism Higher and Lower of judiciary – Constitutional remedies writ jurisdiction Article 32, 226 136 special reference to Mandamus and Certiorari for pollution abatement – Equitable remedies for pollution control.

UNIT IV POLLUTION CONTROL LAWS 8

Administrative regulation under recent legislations in wear pollution control. Water (prevention and control of pollution) Act 1974 as amended by Amendment Act 1988. Water (prevention and control of pollution) Rules 1975 Water (prevention and control or Pollution) Cess Act. 1977 as amended by Amendment Act 1987 and relevant notifications.

UNIT V ENVIRONMENTAL (PROTECTION) ACT 1986 8

Relevant notifications in connection with Hazardous Wastes (management and handling) Biomedical wastes (management and handling), Noise pollution, Eco-labelling, and E.I.A.

TOTAL: 45 PERIODS

REFERENCES:

1. "Constitution of India", 12th Edition, Eastern Book Company, 1997.
2. Pandey, J.N., "Constitutional Law of India", 31st Edition, Central Law Agency 1997.
3. Kesari, U.P.D., "Administrative Law" Universal Book Trade, 1998.
4. Tiwari, H.N., "Environmental Law" Allahabad Law Agency, 1997.
5. Divan, A., and Noble M., "Environmental Law and Policy in India (cases, Materials and Statutes)", Tripathi, 1991.
6. "Environmental Policy. Forest Policy. Bare Acts", Government Gazette Notifiaciton.

EN9009	ENVIRONMENTAL ENGINEERING STRUCTURES	L	T	P	C
		3	0	0	3

UNIT I DESIGN OF PIPES 4

Structural design of a) Concrete b) Prestressed Concrete c) Steel and d) Castiron piping mains, sewerage tanks design – anchorage for pipes – massive outfalls – structural design and laying – hydrodynamic considerations. Advances in the manufacture of pipes.

UNIT II ANALYSIS AND DESIGN OF WATER TANKS 12

Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete. IS Codes for the design of water retaining structures.

Design of circular, rectangular, spherical and Intze type of tanks using concrete. Design of prestressed concrete cylindrical tanks – Economic analysis – introduction to computer aided design and packages.

UNIT III DESIGN OF SPECIAL PURPOSE STRUCTURES 12

Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks

etc. – effect of earth pressure and uplift considerations – selection of materials of construction.

UNIT IV REPAIR AND REHABILITATION OF STRUCTURES 12

Diagonising the cause and damage, identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

UNIT V STUDY ON ENVIRONMENTAL ENGINEERING STEEL STRUCTURES 5

Exposure on Steel, Lattice Structures used in water and sewerage works.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Dayaratnam, P., "Reinforced Concrete".
2. Krishna Raju, "Prestressed Concrete" , 2nd Edition,Tata McGraw-ill Publishing Co. 1988.
3. Sinha, N.C. and Roy, S.K., "Reinforced Concrete", S.Chand and Co. 1985.

REFERENCES:

1. Hulse R. and Mosley, W.H., "Reinforced Concrete Design by Computer", Macmillan Education Ltd., 1986.
2. Ramaswamy, G.S., "Design and Construction of Concrete Shell Roofs", CBS Publishers, 1986.
3. Green, J.K. and Perkins, P.H., "Concrete liquid retaining structures", Applied Science Publishers, 1981.

EN9010 MASS TRANSFER IN AIR-WATER-SOIL INTERACTION

L	T	P	C
3	0	0	3

UNIT I EQUILIBRIUM AT ENVIRONMENTAL INTERFACE 10

Ideal solutions – Air-water equilibrium occurrences – Pure gases in contact with water-Pure liquid in contact with air-partition coefficient for the air – Water system – Earthern solid – Waste equilibrium occurrences – Pure solid and liquid chemicals in contact with water and earthern solids – Earthern solid – Air equilibrium occurrences – Water- liquid chemical equilibrium occurrences – Thermal equilibrium at environmental interfaces.

UNIT II TRANSPORT MECHANISMS 9

Diffusion and mass transfer – Molecular diffusion – Eddy diffusion – Mass transfer theories – Mass transfer coefficients – Binary mass transfer coefficients in two phases and two resistance theory of interphase mass transfer turbulence in the environment – Fundamentals of heat transfer – Analogy theories of momentum, heat and mass transfer.

UNIT III EXCHANGE RATES BETWEEN AIR AND WATER 8

Desorption of gases and liquids from aerated basins and rivers – Completely mixed basin – Plug flow basin – Gas exchange rates between the atmosphere and the surface of rivers – Exchange of chemical across the air – Water interface of lakes and oceans.

UNIT IV EXCHANGE RATES BETWEEN WATER AND THE EARTHERN MATERIAL **9**

Dissolution of chemicals on the bottom of flowing streams – Geometric forms – Stream bottom mass transfer coefficients – Natural convection dissolution – The upsurge of chemicals from the sediment – Water interface of lakes – A Fikian analysis – Annual upsurge rate at sediment – Water interface – Mass transfer coefficients at the sediment – Water interface – Flux of chemicals between sediment and the overlying seawater – Msovement of chemicals through the benthic boundary layer.

UNIT V EXCHANGE RATES BETWEEN AIR AND SOIL **9**

Turbulence above the air-soil interface –Richardson number – Chemical flux rates through the lower layer of the atmosphere – Thronthwaite – Holzman equation – Evaporation of liquid chemicals spilled on land – Chemical flux rates through the upper layer of earthern material.

TOTAL: 45 PERIODS

REFERENCES:

1. Thibodeaux, L.J., "Environmental Chemo dynamics: Movement Of Chemicals In Air, Water and Soil", 2 Edition, Wiley - Interscience, 1996.
2. Cusssler, E.L., "Diffusion: Mass Transfer In Fluid Systems", Cambridge University Press, 1994.

EN9011	MARINE POLLUTION MONITORING	L	T	P	C
		3	0	0	3

UNIT I OCEANOGRAPHY **10**

General features of ocean – Conservation laws – Wave characteristics and theories – Sediment transport – Tides – Ocean Currents – Thermocline circulation – General circulation of ocean waters, Tsunamis, Storm surge – Principles of Marine geology

UNIT II COASTAL ENVIRONMENT **8**

Living resources – coral reefs, mangroves, seagrass, seaweeds, fishery potential – nonliving resources – manganese nodules, heavy minerals – Beaches, Estuaries, Lagoons – Shoreline changes

UNIT III MARINE SURVEYING **6**

Sea surveying planning and preparation – Oceanographic instrumentation – Hydrographic Surveying – Underwater surveying – Measurement of physical properties of ocean water – sea bed sampling

UNIT IV MARINE POLLUTION AND MONITORING **14**

Physiochemical properties of sea water – Sources of marine pollution and impacts on coastal ecosystems, Oil pollution – oil spill detection, dispersion, impacts on adjacent area – Oil spill modeling, mitigation measures – Oil exploration and their effects – Marine outfalls – Impacts of Ports and Harbour on marine water quality – dredging – Human intervention in estuarine ecosystem – sea water classification – Physical modeling in Coastal Engineering – Ocean monitoring satellites – Applications of Remote sensing and GIS in marine studies,

UNIT V MARINE POLLUTION CONTROL 7

National and International treaties, protocols in marine pollution – Exclusive Economic Zone – Sustainable development

TOTAL: 45 PERIODS

REFERENCES

1. Kennish, M.J., "Pollution impacts on Marine Biotic Communities", CRC press 1998
2. Newman, M.C., Roberts Jr. M.H., Male R.C. (Editors), "Coastal and Estuarine Risk Assessment", Lewis Publishers, 2002.
3. "U.S. Army Corps of Engineers", Shore Protection Manual, 2002.

ES9326 UNIT OPERATIONS AND PROCESSES LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To develop the skill for conducting Treatability studies of water and wastewater treatment by various Unit Operations and Processes using laboratory scale models.

LIST OF EXPERIMENTS:

1.	Coagulation and Flocculation	7
2.	Batch studies on settling	10
3.	Studies on Filtration- Characteristics of Filter media	7
4.	Water softening	7
5.	Adsorption studies/Kinetics	7
6.	Reverse Osmosis- Silt Density Index	7
7.	Kinetics of suspended growth process (activated sludge process)- Sludge volume Index	14
8.	Anaerobic Reactor systems / kinetics (Demonstration)	10
9.	Advanced Oxidation Processes – (Ozonation, Photocatalysis)	14
10.	Disinfection for Drinking water	7

TOTAL: 90 PERIODS

REFERENCES:

1. Metcalf and Eddy. Inc. 'Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
2. Lee, C.C. and Shun dar Lin. Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
3. Casey T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wileys Sons, London, 1993.
4. David W.Hendricks, 'Water Treatment Unit Processes: Physical and Chemical', CRC Press, Boca Raton, 2006.