

**AFFILIATED INSTITUTIONS
ANNA UNIVERSITY, CHENNAI
REGULATIONS - 2009**

**M.E. / M.Tech. ENVIRONMENTAL SCIENCE AND ENGINEERING
II TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ES9321	<u>Principles and Design of Biological Treatment Systems</u>	3	0	0	3
2.	EN9325	<u>Environmental Impact Assessment</u>	3	0	0	3
3.	EN9321	<u>Solid and Hazardous Waste Management</u>	3	0	0	3
4.	ES9324	<u>Modeling of Environmental Systems</u>	3	0	0	3
5.	E1***	<u>Elective I</u>	3	0	0	3
6.	E2***	<u>Elective II</u>	3	0	0	3
PRACTICAL						
1.	ES9326	<u>Unit Operations and Processes Laboratory</u>	0	0	4	2
TOTAL			18	0	4	20

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EN9005	<u>Groundwater Contamination and Pollutant Transport Modeling</u>	3	0	0	3
2.	E3***	<u>Elective III</u>	3	0	0	3
3.	E4***	<u>Elective IV</u>	3	0	0	3
PRACTICAL						
1.	ES9333	Project Work (Phase-I)	0	0	6	3
2.	ES9334	Practical Training (4 weeks)	-	-	-	1
TOTAL			9	0	6	13

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	ES9341	Project Work (Phase-II)	0	0	30	12
TOTAL			0	0	30	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 68

ELECTIVES M.E / M.TECH ENVIRONMENTAL SCIENCE AND ENGINEERING

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ES9001	<u>Industrial Wastewater Pollution- Prevention and Control</u>	3	0	0	3
2.	ES9002	<u>Environmental Quality Monitoring</u>	3	0	0	3
3.	ES9003	<u>Soil Pollution Engineering</u>	3	0	0	3
4.	ES9004	<u>Remote Sensing and GIS Applications in Environmental Engineering</u>	3	0	0	3
5.	ES9005	<u>Climate change and Adaptation</u>	3	0	0	3
6.	EN9008	<u>Environmental Policies and Legislation</u>	3	0	0	3
7.	ES9007	<u>Environmental Risk Assessment and Management</u>	3	0	0	3
8.	EN9006	<u>Environmental Biotechnology</u>	3	0	0	3
9.	ES9009	<u>Atmospheric Science</u>	3	0	0	3
10.	ES9010	<u>Environmental Nanotechnology</u>	3	0	0	3
11.	ES9011	<u>Wastewater Engineering</u>	3	0	0	3
12.	ES9012	<u>Energy Management</u>	3	0	0	3
13.	ES9013	<u>Environmental Management</u>	3	0	0	3
14.	ES9014	<u>Indoor Air Quality</u>	3	0	0	3

OBJECTIVE:

- To educate the students on principles and design of various biology treatment units used for wastewater treatment.

UNIT I PRINCIPLES 10

Objectives of biological treatment – significance – aerobic and anaerobic treatment kinetics of biological growth – Factors affecting growth – attached and suspended growth Determination of Kinetic coefficients for organics removal – Biodegradability assessment -selection of process- reactors-batch-continuous type-kinetics

UNIT II DESIGN OF AEROBIC TREATMENT SYSTEMS 10

Design of sewage treatment plant units –Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-RBC-Moving Bed Reactors-fluidized bed reactors, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems, constructed wet land – Disinfectant – disposal options – reclamation and reuse – Flow charts, layout, hydraulic profile, recent trends.

UNIT III ANAEROBIC TREATMENT OF WASTEWATER 10

Attached and suspended growth, Design of units – UASB, up flow filters, Fluidized beds septic tank and disposal – Nutrient removal systems – Flow chart Layout and Hydraulic profile – Recent trends.

UNIT IV SLUDGE TREATMENT AND DISPOSAL 5

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity) Layout PID hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.

UNIT V CONSTRUCTION OPERATIONS AND MAINTENANCE ASPECTS 10

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organising and Controlling of plant operations – capacity building, Case studies – sewage treatment plants – sludge management facilities.

TOTAL: 45 PERIODS**REFERENCES:**

1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.
2. Manual on “Sewerage and Sewage Treatment” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. Metcalf & Eddy, INC, ‘Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 2003.
4. Qasim, S.R. Wastewater Treatment Plant, Planning, Design & Operation, Technomic Publications, New York, 1994.

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.

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.

UNIT I**9**

Basic concepts in ecology and ecological modeling, Population Dynamics: Birth and death processes. Single species growth, Prey-predator models: Lotka-Volterra, Rosenzweig-MacArther, Kolmogorov models. Multi-species modeling, Primary production, primary and secondary consumers, Structural analysis and stability of complex ecosystems.

UNIT II**9**

Continuous-Flow Reactor Modeling: CSTR, Plug-Flow, Dispersion. A case study of a tubular reactor with axial dispersion, Parameter Calibration: Search algorithms for nonlinear dynamical models, Variance of estimated parameters. Application to Monod and Haldane kinetics.

UNIT III**9**

Basic mechanisms of river self-purification, Streeter-Phelps and Dobins models. More complex chemical and ecological models. Pollutant and nutrient dynamics. Dissolved Oxygen dynamics.

UNIT IV**9**

Fundamentals of microbial dynamics and energetics. Pollutant/Microorganisms interactions, Requirements for carbon and nutrient removal. Activated sludge: Process schemes: completely mixed, plug-flow, SBR, nutrient removal. Anaerobic digestion: process dynamics, Operational control of wastewater treatment processes.

UNIT V**9**

Fuzzy System Modeling Introduction to fuzzy sets and systems, fuzzification, implication, connectives, defuzzification, rule-based fuzzy models with different approaches (Mamdani and Sugeno). Cluster analysis for the classification of ecological data. Integration between fuzzy clustering and fuzzy models.

REFERENCES:

1. Deaton, M.L and Winebrake, J.J., Dynamic Modeling of Environmental Systems, Springer-Verlag, 2000.
2. Orhon, D and Artan, N., Modeling of Activated Sludge Systems, Technomic Publ. Co., 1994.
3. Chapra, S.C. Surface Water-Quality Modeling, McGraw-Hill, 1997

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 ¹⁴C Dates – Process rates and molecular diffusion.

UNITV 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.

2. Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007
3. Frank Woodard, 'Industrial waste treatment Handbook', Butterworth Heinemann, New Delhi, 2001.
4. World Bank Group, 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production', World Bank and UNEP, Washington D.C., 1998
5. Paul L. Bishop, 'Pollution Prevention: - Fundamentals and Practice', Mc-Graw Hill International, Boston, 2000.

ES9002

ENVIRONMENTAL QUALITY MONITORING

L T P C
3 0 0 3

OBJECTIVE:

To educate the students on the various instrumental methods of monitoring the quality of air, water and soil.

UNIT I INTRODUCTION 9

Wet Chemistry methods and their limitations-Instrumental Methods, Selection of method- Precision and Accuracy, Error in measuring signals- Quality control & assurance- Sample preservation, Sample preparation and analyte isolation.

UNIT II SPECTROSCOPIC METHODS 12

Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace and hydride generation), Atomic Emission Spectrometry (AES) , flame and Inducted Coupled Plasma (ICP) – TOC Analyzer

UNIT III CHROMATROGRAPHIC METHODS 8

Column, Paper and thin layer chromatography (TLC)- Principles, techniques and applications of GC, GC-MS, High performance liquid chromatography (HPLC) and Ion chromatograph (IC)-Hyphenated techniques for Environmental contaminant(trace organics) analysis.

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS 8

Principles, techniques and applications of Conductometry, potentiometry, coulometry, AOX analyzer Amperometry, polarography, New Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS 8

Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOx Fluorescent analyzer for SO2- Particulates analysis- Auto analyzer for water quality using flow injection analysis.

TOTAL: 45 PERIODS

UNIT V SOIL REMEDIATION TECHNOLOGIES 10

Contaminated site characterization – Containment – Soil vapour extraction - Soil washing – Solidification and Stabilization – Electro-kinetic remediation – Thermal desorption – Vitrification – In-situ and Ex-situ Bioremediation – Phytoremediation – Soil fracturing – Biostimulation – Bioaugmentation –Chemical oxidation and reduction.

TOTAL: 45 PERIODS

REFERENCES:

1. Calvin Rose, An Introduction to the Environmental Physics of Soil, Water and Water Sheds, Cambridge University Press, 2004.
2. Paul Nathanail C. and Paul Bardos R., Reclamation of Contaminated Land, John Wiley & Sons Limited, 2004.
3. Hari D. Sharma and Krishna R. Reddy, Geo-Environmental Engineering : Site Remediation, Water Contaminant and Emerging Water Management Technologies, John Wiley & Sons Limited, 2004.
4. Marcel Vander Perk, Soil and Water Contamination from Molecular to Catchment Scale, Taylor & Francis, 2006.
5. William J. Deutsch, Groundwater Geochemistry : Fundamentals and Applications to Contamination, Lewis Publishers, 1997.

ES9004 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING L T P C 3 0 0 3

OBJECTIVE:

- To educate the students on the principles and applications of Remote sensing and GIS in environmental management.

UNIT I OVERVIEW OF REMOTE SENSING 5

Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Energy interaction, Spectral response pattern of earth surface features

UNIT II REMOTE SENSING TECHNOLOGY 11

Classification of Remote Sensing Systems, Energy recording technology, Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR, Satellites and their sensors, Indian space programme - Research and development

UNIT III DATA PROCESSING 11

Characteristics of Remote Sensing data, Photogrammetry – Satellite data analysis – Visual image interpretation, Digital image processing – Image rectification, enhancement, transformation, Classification, Data merging, RS – GIS Integration, Image processing software.

UNIT IV GEOGRAPHICAL INFORMATION SYSTEM 6
 GIS Concepts – Spatial and non spatial data, Vector and raster data structures, Data analysis, Database management – GIS software

UNIT V REMOTE SENSING AND GIS APPLICATIONS 12
 Monitoring and management of environment, Conservation of resources, Sustainable land use, 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, New York, 2004.
2. Golfried Konechy, Geoinformation: Remote sensing, Photogrammetry and Geographical Information Systems, CRC press, 1st Edition, 2002.
3. Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information systems Oxford University Press, New York, 2001.
4. Lintz, J. and Simonet, Remote sensing of Environment, Addison Wesley Publishing Company, New Jersey, 1998.
5. Pmapler and Applications of Imaging RADAR, Manual of Remote Sensing, Vol.2, ASPR, 2001.

ES9005 CLIMATE CHANGE AND ADAPTATION L T P C
3 0 0 3

OBJECTIVE:

- To understand the Earth’s Climate System and the concept of Global Warming, the impact of climate change on society and its mitigation measures.

UNIT I EARTH’S CLIMATE SYSTEM 9
 Introduction-Climate in the spotlight - The Earth’s Climate Machine – Climate Classification - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation –The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

UNIT II OBSERVED CHANGES AND ITS CAUSES 9
 Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC –Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.

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 Notificaiton.

ES9007 ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT L T P C 3 0 0 3

OBJECTIVE:

- To provide knowledge related to the broad field of environmental risk assessment, important processes that control contaminant transport and tools that can be used in predicting and managing human health risks.

UNIT I INTRODUCTION 6

Sources of Environmental hazards – Environmental and ecological risks – Environmental risk assessment framework – Regulatory perspectives and requirements – Risk Analysis and Management and historical perspective; Social benefit Vs

technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines.

UNIT II ELEMENS OF ENVIRONMENTAL RISK ASSESSMENT 10

Hazard identification and accounting – Fate and behaviour of toxics and persistent substances in the environment – Properties, processes and parameters that control fate and transport of contaminants – Receptor exposure to Environmental Contaminants – Dose Response Evaluation – Exposure Assessment – Exposure Factors, Slope Factors, Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis.

UNIT III TOOLS AND METHODS FOR RISK ASSESSMENT 12

HAZOP and FEMA methods – Cause failure analysis – Event tree and fault tree modeling and analysis – Multimedia and multipathway exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products – Estimation of carcinogenic and non carcinogenic risks to human health – Methods in Ecological risk assessment – Probabilistic risk assessments – radiation risk assessment – Data sources and evaluation.

UNIT IV RISK MANAGEMENT 8

Risk communication and Risk Perception – comparative risks – Risk based decision making – Risk based environmental standard setting – Risk Cost Benefit optimization and tradeoffs – Emergency Preparedness Plans – Emergency planning for chemical agent release – Design of risk management programs – risk based remediation; Risk communication, adaptive management, precaution and stake holder involvement.

UNIT V APPLICATIONS 9

Case studies on risk assessment and management for hazardous chemical storage – Chemical industries – Tanneries – Textile industries – Mineral processing and Petrochemical plants – Hazardous waste disposal facilities – nuclear power plants – contaminated site remediation – Case histories on Bhopal, Chernobyl, Seveso, Three Mile Island.

TOTAL: 45 PERIODS

REFERENCES:

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
3. Kofi Asante Duah, "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
4. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
5. Risks and Decisions for Conservation and environmental management, Mark Burman, Cambridge University Press.
6. Susan L |Cutter, "Environmental Risks and Hazards" Prentice Hall of India, New Delhi, 1999.
7. Joseph F Louvar and B Diane Louver, Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey, 1997.

UNIT I INTRODUCTION 5

Principles and concepts of environmental biotechnology—usefulness 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.

ES9009

ATMOSPHERIC SCIENCE

L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction: Definitions and terms – A brief survey of atmosphere: optical properties, mass, chemical composition, structure, winds and precipitation. Components of Earth system – Hydrologic cycle – Carbon cycle – Oxygen in earth system – Climate and earth system

UNIT II ATMOSPHERIC THERMODYNAMICS 9

Atmospheric thermodynamics – The hydrostatic equation – First law of thermodynamics – adiabatic processes – water vapor in air – moisture parameters, latent heats – Normand’s rule – Unsaturated air, saturated air – second law of thermodynamics.

UNIT III ATMOSPHERIC CHEMISTRY 9

Composition of tropospheric air – Sources, transport and sinks of trace gases – Tropospheric aerosols – air pollution – tropospheric chemical cycles – stratospheric chemistry

UNIT IV ATMOSPHERIC DYNAMICS 9

Kinematics of the large-scale horizontal flow – Dynamics of horizontal flow – primitive equations – atmospheric general circulation – numerical weather prediction

UNIT V CLIMATE 9

The present day climate – Climate variability – Climate equilibrium, sensitivity – Green house warming – Climate changes – Climate monitoring and prediction – weather systems – tropical cyclones – case studies: tsunami and sea level rising, Acid rain– The concept of El Nino.

TOTAL : 45 PERIODS

REFERENCES:

1. John.M.Wallace, Peter.V.Hobbs, Atmospheric science: An introductory survey, 2nd edition, Academic press, 2006.
2. C. N. Hewitt, Andrea V. Jackson, Handbook of Atmospheric Science: Principles and Applications, Blackwell Publishing, 2003.
3. John E. Frederick, Principles of Atmospheric Science, Jones & Bartlett Publishers, 2007.

ES9010

ENVIRONMENTAL NANOTECHNOLOGY

L T P C
3 0 0 3

UNIT I GENERAL 9

Background of nanotechnology, particle size and surface area, quantum dot. Converging science and technology, nanotechnology as a tool for sustainability, health, safety and environmental issues.

UNIT II SYNTHESIS AND FABRICATION OF NANOMATERIALS 9

Preparation of nanoscale metal oxides, metals, CNT, functionalized nanoporous adsorbents, nano composite- Chemical Vapour Deposition, sol gel, sonochemical,

microwave, solvothermal, plasma, pulsed laser ablation, magnetron sputtering, electrospinning, Molecular imaging.

UNIT III CHARACTERISATION OF NANOMATERIALS 9
AFM, STM, SEM, TEM, XRD, ESCA, IR & Raman, UV-DRS, of nanomaterials for structural & chemical nature.

UNIT IV OTHER FEATURES OF NANO PARTICLES 9
Nanoparticle transport, aggregation & deposition. Energy applications-H₂ storage

UNIT V ENVIRONMENTAL APPLICATIONS 9
Gas sensors, microfluidics and lab on chip, catalytic and photocatalytic applications, Nanomaterials for ground water remediation, nanomaterials as adsorbents, membrane process.

TOTAL : 45 PERIODS

REFERENCES:

1. ENVIRONMENTAL APPLICATIONS OF NANOMATERIALS-Synthesis, Sorbents and Sensors, edited by Glen E Fryxell and Guozhong Cao, worldscibooks, UK
2. Environmental nanotechnology, Mark Wisener, Jeo Yues Bolteru, 2007, McGraw Hill.
3. The Chemistry of Nanomaterials, Synthesis, Properties and applications. Edited by C.N.R.Rao.
4. Müller, A.K.Cheetham Copyright 8 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
5. Handbook of Nanotechnology, Edi-Bharat Bhushan, Springer, 2004

ES9011 WASTEWATER ENGINEERING L T P C
3 0 0 3

UNIT I INTRODUCTION 10
Industrial scenario - Uses of Water by industry - Sources and types of industrial wastewater – Industrial wastewater disposal and environmental impacts - Reasons for treatment of industrial wastewater – Regulatory requirements - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests - Preventing and minimizing wastes at the source - Individual and Common Effluent Treatment Plants - Joint treatment of industrial wastewater.

UNIT II INDUSTRIAL WASTEWATER TREATMENT 10
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

UNIT III ADVANCED WASTEWATER TREATMENT AND REUSE 8
Chemical oxidation - Ozonation - Photocatalysis - Wet Air Oxidation - Evaporation - Ion Exchange – Membrane Technologies - Nutrient removal - Land Treatment.

UNIT IV RESIDUALS MANAGEMENT 5
 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 and waste treatment flow sheet for Textiles - Tanneries - Pulp and paper - metal finishing - Petroleum Refining - Chemical industries - Sugar and Distilleries -Dairy - Iron and steel - fertilizers - Industrial clusters and Industrial Estates.

TOTAL: 45 PERIODS

REFERENCES:

1. Eckenfelder, W. W., "Industrial Water Pollution Control", Mc-Graw Hill, 1999.
2. Arceivala, S. J., "Wastewater Treatment for Pollution Control", Tata McGraw Hill, 1998.
3. "Pollution Prevention and Abatement Handbook – Towards Cleaner Production ", World Bank and UNEP, Washington, 1998.

ES9012 ENERGY MANAGEMENT L T P C
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UNIT I 9
 Energy sources; coal oil, natural gas; nuclear energy; hydro electricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.

UNIT II 9
 Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modeling and optimal mix of energy sources. Energy; various forms; energy storage; structural properties of environment;

UNIT III 9
 Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution; growth and change; patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit

UNIT IV 9
 Chemical industries; classification; conservation in unit operation such as separation; cooling tower; drying; conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries, chloro alkali industries; conservation using optimization techniques.

UNIT V 9
 Sources of continuous power; wind and water; geothermal; tidal and solar power; MHD, fuel cells; hydrogen as fuel. Cost analysis; capacity; production rate; system rate; system cost analysis; corporate models; production analysis and production using fuel inventories; input-output analysis; economics; tariffs.

TOTAL : 45 PERIODS

REFERENCES:

1. Krentz, J. H., Energy Conservation and Utilisation , Allyn and Bacur Inc., 1976.
2. Gramlay, G. M., Energy , Macmillan Publishing Co., New York, 1975.
3. Rused, C. K., Elements of Energy Conservation , McGraw-Hill Book Co., 1985.

ES9013 ENVIRONMENTAL MANAGEMENT L T P C
3 0 0 3

UNIT I 8
Environmental Legislations in India, Europe, USA and Canada – Development of Legislations, Standards and Guidelines

UNIT II 5
Water (Prevention and control of Pollution) Act 1974, Air (Prevention and Control of Pollution) Act 1981, Environmental Protection Act 1986, Hazardous Waste management Rules and Guidelines for siting of industries. Standards for discharge of treated liquid effluent into water bodies, including inland water bodies, and sea, standards for disposal of air emissions (SO₂,SPM,NH₃, H₂S and HC) into atmosphere.

UNIT III 8
Factory Act 1987 of India, Occupational health and safety requirements and standards of ILO, Compliance of rules and guidelines of Factory Act applicable to industries.

UNIT IV 10
Principles of Environmental impact assessment and audit guidelines and legislature requirements for siting of industrial units in estates/complex. Preparatory procedures for EIA study, Evaluation of impact on air, water and land environment.

UNIT V 14
Principles of Environmental Auditing, Cleaner Technologies in Industrial Processes and evaluation of processes Auditing techniques in Preparing EA. Monitoring of ambient environment, including air, water and land, noise, liquid and solid waste management.

TOTAL: 45 PERIODS

REFERENCES:

1. Canter, W.L., Environmental Impact Assessment, McGraw-Hill Inc., 1992
2. Rau, J.G and Wooten, D.C., Environmental Impact Analysis Handbook, McGraw-Hill, 1980.
3. Jain, R.K., Urban, L.V., Stacey, G.S. and Balbach, H.E., Environmental Assessment, McGraw-Hill, 1993.
4. UNEP/IED Technical Report Serial No.2., Environmental Auditing, 1990

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 : 45 PERIODS

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, Elsevier Science, Vol. 3, 1995