UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.TECH. ENVIRONMENTAL SCIENCE AND TECHNOLOGY

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA9120	Advanced Numerical Methods	3	1	0	4
2.	EV9111	Environmental Science	3	0	0	3
3.	EV9112	Unit Operations and Unit Processes in Environmental Technology	3	0	0	3
4.	EV9113	Biological Waste Water Treatment	3	0	0	3
5.	E1	Elective I	3	0	0	3
6.	E2	Elective II	3	0	0	3
PRACTICAL						
7.	EV9116	Environmental Engineering Lab I	0	0	2	2
		TOTAL CREDITS	**18**	**1**	**2**	**21**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EV9121	Separation Processes in Environmental Applications	3	0	0	3
2.	EV9122	Air Pollution Control	3	0	0	3
3.	EV9123	Environmental Impact Assessment	3	0	0	3
4.	EV9124	Solid and Hazardous Waste Management	3	0	0	3
5.	E3	Elective III	3	0	0	3
6.	E4	Elective IV	3	0	0	3
PRACTICAL						
7.	EV9127	Environmental Engineering Lab II	0	0	4	2
		TOTAL CREDITS	**18**	**0**	**4**	**20**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EV9131	Modeling of Environmental Systems	3	0	0	3
2.	E5	Elective V	3	0	0	3
3.	E6	Elective VI	3	0	0	3
PRACTICAL						
7.	EV9134	Project Work (Phase I)	0	0	12	6
		TOTAL CREDITS	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	EV9141	Project Work (Phase II)	0	0	24	12
		TOTAL CREDITS	**0**	**0**	**24**	**12**

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

LIST OF ELECTIVES

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CL9112	Advanced Transport Phenomena	3	0	0	3
2.	EV9151	Atmospheric Science	3	0	0	3
3.	EV9152	Environmental Reaction Engineering	3	0	0	3
4.	EV9153	Industrial Pollution Prevention	3	0	0	3
5.	EV9154	Advanced Oxidation Processes and Technology	3	0	0	3
6.	EV9155	Pollution Abatement	3	0	0	3
7.	EV9156	Environmental Nanotechnology	3	0	0	3
8.	EV9157	Waste Water Engineering	3	0	0	3
9.	EV9158	Energy Management	3	0	0	3
10.	EV9159	Green Chemistry and Engineering	3	0	0	3
11.	EV9160	Environmental Sustainability	3	0	0	3
12.	EV9161	Environmental Risk Assessment	3	0	0	3
13.	EV9162	Ecology and Environment	3	0	0	3
14.	EV9163	Environmental Management	3	0	0	3
15.	EV9164	Environmental Biotechnology	3	0	0	3

MA9120 ADVANCED NUMERICAL METHODS L T P C
3 1 0 4

UNIT I ALGEBRAIC EQUATIONS 6

Systems of linear equations – Jacobi, Gauss Seidel, SOR methods, Thomas algorithm for tridiagonal systems; Systems of nonlinear equations - successive approximation method, methods for improved convergence, Newton Method and its variants, continuation methods for multiple solutions.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS – IVPS 6

Runge Kutta Methods, step size control and estimates of error, numerical stability, solution of stiff ODEs, ODE-IVPs coupled with algebraic equations;

UNIT III ORDINARY DIFFERENTIAL EQUATIONS – BVPS 12

Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method, shooting technique.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS – FINITE DIFFERENCE METHOD 12

Parabolic equations – Different explicit and implicit methods, alternating direction explicit and implicit methods; Elliptic equations – Point iterative methods, line iterative methods, ADI methods; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS – FINITE ELEMENT METHOD 9

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

L : 45 , T : 15, TOTAL : 60 PERIODS

REFERENCES

1. Gupta, S.K., Numerical Methods for Engineers, New Age Publishers, 1995
2. Jain, M. K., S. R. Iyengar, M. B. Kanchi, R. K. Jain, Computational Methods for Partial Differential Equations, New Age Publishers, 1993.

EV 9111 ENVIRONMENTAL SCIENCE L T P C
3 0 0 3

UNIT I 9

Significance of Environmental Chemistry for Wastewater Engineering- Basic concepts of cell biology, metabolism, energetic of bio chemical reactions, enzymes and their importance in aerobic and anaerobic microbiological reactions, specific importance of co-factors, transport of materials in the organisms

UNIT II 9

Chemical equilibrium in gaseous and solutions, free energy change, entropy change of reactions in solutions,

UNIT III 9

Basic concepts of electro chemistry, Debye-Huckel Theory, solubility of strong electrolytes, acids and bases, buffers, pH, interpretation of pH data. Colloids, osmosis, viscosity of colloidal suspension, Brownian movement and diffusion sedimentation, surface forces, electrical properties of surfaces

UNIT IV **9**

Colloids, osmosis, viscosity of colloidal suspension, Brownian movement and diffusion sedimentation, surface forces, electrical properties of surfaces

UNIT V **9**

Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods - Sampling and analysis of ambient air for SPM, SO2, and Oxides of nitrogen - Good laboratory practice - Analytical quality control.

TOTAL: 45 PERIODS

REFERENCES

1. Sawyer C L McCarty P L and Parkin G E, Chemistry for Environmental Engineering. McGraw Hill, 1995
2. Rajeshwar, K. and Ibanez, J. G., Environmental Electrochemistry Academic Press, 1997.
3. VanLoon G W and S.J. Duffy, Environmental Chemistry, Oxford university press, 2005

EV 9112	UNIT OPERATIONS AND PROCESSES IN ENVIRONMENTAL TECHNOLOGY	L T P C 3 0 0 3

UNIT I **9**

Selection of unit operations and processes - Principal type of Reactors -Screening - Mixing - Coagulation and Flocculation – Flow equalization

UNIT II **9**

Sedimentation - Type of settling - Removal ratio – Clarifier-thickener- Column flotation- air flotation.

UNIT III **9**

Filtration – classification of filters-Head loss through filters– Darcy equation-

UNIT IV **9**

Chemical precipitation - phosphate removal - Adsorption - Activated carbon - Isotherms – Disinfection – Factors Influencing - Breakpoint chlorination - Dechlorination.

UNIT V **9**

Kinetics of Biological growth - Suspended and attached growth processes - Aerobic and Anaerobic - Determination of kinetic coefficients.

TOTAL: 45 PERIODS

REFERENCES

1. METCALF & EDDY, INC. " Wastewater Engineering - Treatment, Disposal, and Reuse ", Third Edition, Tata McGraw-Hill, 1995.
2. Casey. T.J. " Unit Treatment Processes in Water and Wastewater Engineering ", John Wiley & Sons, 1993.

EV 9113 BIOLOGICAL WASTEWATER TREATMENT L T P C
3 0 0 3

UNIT I **9**

Classification of Biochemical Operations, Fundamentals of Biochemical Operations, Stoichiometry and Kinetics of Biochemical Operations.

UNIT II **9**

Theory, Modeling of Ideal Suspended Growth Reactors, Modeling Suspended Growth Systems, Aerobic Growth of Heterotrophs in a Single Continuous Stirred Tank, Reactor Receiving Soluble Substrate, Multiple Microbial Activities in a Single Continuous Stirred Tank Reactor, Multiple Microbial Activities in Complex Systems, Techniques for Evaluating Kinetic and Stoichiometric Parameters

UNIT III **9**

Applications: Suspended Growth Reactors, Design And Evaluation of Suspended Growth Processes, Activated Sludge, Biological Nutrient Removal, Aerobic-digestion, Anaerobic Processes, Lagoons

UNIT IV **9**

Theory: Modeling of Ideal Attached Growth Reactors, Bio-film Modeling Aerobic Growth of Biomass in Packed Towers, Aerobic Growth of Heterotrophs in Rotating Disc Reactors, Fluidized Bed Biological Reactors,

UNIT V **9**

Applications: Attached Growth Reactors, Trickling Filter, Rotating Biological Contactor, Submerged Attached Growth Bioreactors, Future Challenges, Fate and Effects of Xenobiotic Organic Chemicals

TOTAL: 45 PERIODS

REFERENCES

1. Grady, C.P.L, Daigger, G and Lim, H.C, Biological Wastewater Treatment, 2nd Edn, Marcel Dekker, 1998
2. Mizrahi A, Biological Waste Treatment, John Wiley Sons Inc 1989

EV 9116 ENVIRONMENTAL ENGINEERING LAB - I L T P C
0 0 4 2

1. Determination of pH, Alkalinity, Hardness, and Conductance of industrial wastewater.
2. Determination of TS, TSS, TDS, Fixed, Volatile, Floatable, Settleable solids
3. Studies on Jar Test apparatus
4. Determination of Biochemical Oxygen Demand (BOD)
5. Determination of Chemical Oxygen Demand (COD)
6. Determination of total Coli form counting in given wastewater
7. Determination of residual chlorine in ground water
8. Estimation of organic compounds present in the wastewater
9. Estimation of Nutrients (Nitrate and Phosphate) present in the wastewater. Nitrogen estimation.
10. Performance studies on sonochemical reactor for wastewater treatment.

TOTAL: 60 PERIODS

EV 9121 SEPARATION PROCESSES IN ENVIRONMENTAL APPLICATIONS **L T P C**
3 0 0 3

UNIT I **9**

Pollution sources, Environmental separations-Historic perspective of environmental pollution- Separation mechanisms -Equilibrium-based processes, Rate-based processes Countercurrent operation, Productivity and selectivity, separating agents,

UNIT II **9**

Degrees of freedom analysis, Phase equilibrium, Equilibrium-limited analysis, Minimum number of stages, Rate-limited processes, Batch and Continuous distillation, Extraction in Environmental applications, Leaching processes, McCabe–Thiele analysis

UNIT III **9**

Absorption and stripping, stripping, packed columns, Adsorption principles, Sorbent selection-regeneration, Transport processes, Process design factors, Design of fixed-bed adsorption

UNIT IV **9**

Ion exchange- Objectives, Environmental applications, Ion-exchange mechanisms, Ion-exchange media, Equipment and design procedures.

UNIT V **9**

Membranes-Pluses and minuses for membrane processes, Environmental applications, Separation mechanisms-Membrane processes, membrane performance

TOTAL: 45 PERIODS

REFERENCES

1. Noble, R.D and Terry P.A., Principles of Chemical Separations with Environmental Applications, Cambridge University Press, 2004
2. Treybal R E, Mass Transfer Operations, McGraw Hill 1981
3. Seader J D and Henley E J, Separation Processes Principles, John Wiley, 1998

EV 9122 **AIR POLLUTION CONTROL** **L T P C**
3 0 0 3

UNIT I **9**

Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Fate and Transport in the Environment; Priority Air Pollutants; Indoor Air Quality

UNIT II **9**

Industrial Air Pollution Sources and Prevention; Air Pollution in the Chemical Process, Petroleum, Iron and Steel Manufacturing, Lead and Zinc Smelting Industries, Air Pollution from Nickel Ore Processing and Refining; Air Pollution from Aluminum Manufacturing; Air Pollution from Copper Smelting;

UNIT III **9**

Properties of Air Pollutants; Selected Chemical and Physical Properties of Potential Atmospheric Pollutants; Basic Properties and Terminology;

UNIT IV **9**

Ventilation and Indoor Air Quality Control; An Overview of Indoor Air Quality; The Basics of HVAC Systems; IAQ Issues and Impacts on Occupants; Application of Audits to Developing an IAQ Profile; Developing Management Plans; IAQ Problems; Control; Quantification and Measurement, Air Pollution Dispersion-Dispersion Theory Basics- Air Quality Impact of Stationary Sources- Models and Resources

UNIT V **9**

Prevention Versus Control; Pollution Prevention: Principles of Pollution Prevention; Methods of Particulate Collection; Methods for Cleaning Gaseous Pollutants, Environmental Cost Accounting; Total Cost Accounting Terminology;

TOTAL: 45 PERIODS

REFERENCES

1. Nicholas P. Cheremisinoff, Handbook of Air Pollution Prevention and Control. Butterworth-Heinemann, 2002
2. Heck, R.M and Farrauto, R.J, Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2002
3. Noel de Nevers, Air Pollution Control Engineering, McGraw Hill, 1994

EV 9123 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

UNIT I **9**

Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS) - Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India - Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national – cross-sectoral - social and cultural.

UNIT II **12**

Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices - Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmental decision-making.

UNIT III **6**

Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA - use of regulations and AQM.

UNIT IV **9**

Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Environmental monitoring - guidelines - policies - planning of monitoring programmes. Environmental Management Plan. Post project audit.

UNIT V **9**

Case studies of EIA of developmental projects

TOTAL: 45 PERIODS

REFERENCES

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York, 1996.
2. Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 1999.
3. The World Bank Group, Environmental Assessment Sourcebook Vol. I, II and III, The World Bank, Washington, 1991

EV 9124 SOLID AND HAZARDOUS WASTE MANAGEMENT **L T P C**
3 0 0 3

UNIT I **9**

Legal and Organizational foundation: Definition of solid waste - waste generation in a technological society - major legislation, monitoring responsibilities, sources and types of solid waste - sampling and characterization - Determination of composition of MSW-storage and handling of solid waste - Future changes in waste composition.

UNIT II **9**

Collection of Solid Waste: type of waste collection systems, analysis of collection system - alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery facilities, Waste transformation through combustion and anerobic composting, anaerobic methods for materials recovery and treatment - Energy recovery - Incinerators. Transfer and Transport: need for transfer operation, transport means and methods, transfer station types and design requirements. Landfills: Site selection, design and operation, drainage and leachate collection systems - requirements and technical solutions, designated waste landfill remediation - Integrated waste management facilities.

UNIT III **9**

Definition and identification of hazardous wastes - sources and characteristics - hazardous wastes in Municipal Waste - Hazardous waste regulations -minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste - collection and transport.

UNIT IV **9**

Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste - Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation- remediation of hazardous waste disposal sites.

UNIT V **9**

Sampling and characterization of Solid Wastes; TCLP tests and leachate studies

TOTAL: 45 PERIODS

REFERENCES

1. Techobanoglous G, Integrated Solid Waste Management, McGraw- Hill Publication, 1993.
2. Wentz C A, Hazardous Waste Management, McGraw-Hill Publication, 1995.

EV 9127 ENVIRONMENTAL ENGINEERING LAB – II L T P C
0 0 4 2

1. Studies on isolation of microorganism for wastewater treatment
2. Biosorption of heavy metals using biomass
3. Studies on Electro deposition of heavy metals
4. Studies on treatment of effluents using electrochemical reactor.
5. Estimation of light metals using flame photometer
6. Determination of sludge volume index
7. Physiochemical analysis of solid wastes
8. Determination of particle cut diameter in Cyclone separator
9. Design of clarifier by using the data obtained through batch sedimentation.
10. Batch adsorption studies using activated carbon and dye.

TOTAL : 60 PERIODS

EV 9131 MODELING OF ENVIRONMENTAL SYSTEMS L T P C
3 0 0 3

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.

TOTAL : 45 PERIODS

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.

EV 9134 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

Students have to do a research project in the department or in an industry and submit a report at the end of the Phase I.

EV 9141 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

Students have to do a research project in the department or in an industry and submit a report at the end of the Phase II.

CL9112 **ADVANCED TRANSPORT PHENOMENA** **L T P C**
3 0 0 3

UNIT I BASIC CONCEPTS **6**

Viscosity, mechanism of momentum transport, shell balance method, Newton's law, pressure and temperature effect on viscosity of gases and liquids, velocity distributions in falling film, circular tube, annulus, slit. Phenomenological Equations and Transport properties, Rheological behavior of fluids, Balance Equations – Differential and Integral equations

UNIT II APPLICATIONS OF DIFFERENTIAL EQUATIONS OF CHANGE **6**

Applications in laminar and Turbulent transport in compressible and incompressible fluids. Boundary layer theory

UNIT III INTERPHASE AND MULTIPHASE MOMENTUM TRANSFER **10**

Friction factor, Fluid –Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces

acting on stagnant and moving solids, Flow through porous medium, Capillary tube model and its applications.

UNIT IV INTERPHASE TRANSPORT IN NON-ISOTHERMAL SYSTEMS 8

Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat transfer, Heat transfer in boiling liquids.

UNIT V INTERPHASE MASS TRANSFER AND MACROSCOPIC BALANCES FOR MULTICOMPONENT SYSTEM 7

Mass Transfer co-efficient in single and multiple phases at low and high mass transfer rates, Film theory, Penetration theory, Boundary layer theory, Macroscopic balance to solve steady and Unsteady state problems.

TOTAL : 45 PERIODS

REFERENCES

1. Bird R.B., Stewart, W. E. and Lightfoot, E. N., Transport Phenomena, 2nd Edn., John Wiley Sons, 2002.
2. Welty, J.R., Wicks, C. E. and Wilson, R. E., Fundamentals of Momentum, Heat Mass Transfer, 3rd Edn., John Wiley Sons, 1984.
3. Brodkey, R. S. and Hershey, H. C., Transport Phenomena, McGraw Hill, 1988.

EV 9151 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.

EV 9152 ENVIRONMENTAL REACTION ENGINEERING L T P C
3 0 0 3

UNIT I **9**

Reaction engineering principles with applications to environmental systems, general reaction mechanisms, Rate Relationships: Concepts and Applications to Homogeneous Systems and Heterogeneous Systems with respect to chemical and biological reactions.

UNIT II **9**

Ideal systems modeling and design, reactor concepts, ideal reactors, reaction rate measurements, Hybrid system modeling and design, Sequencing batch reactor, Reactors in series and reactors with recycle.

UNIT III **9**

Non ideal system modeling and design, non ideal reactor behavior, RTD analysis, PFDR model

UNIT IV **9**

Reactive interphase mass transfer, Fluid –solid surface reactions, Gas-liquid bulk phase reactions, adsorption in porous solids, Fluid solid processes and gas-liquid processes

UNIT V **9**

Biological reaction engineering; biological kinetics; enzyme kinetics; Michaelis-Menten equation; simple microbial kinetics; structured kinetic models biological reaction engineering; basic bioreactor concepts; bioreactor modelling; bioreactor operation; batch operation; semicontinuous operation; fed batch operation; continuous operation, and its environmental applications

TOTAL : 45 PERIODS

REFERENCES

1. Weber, W.J. and Di Giano, F.A., Process Dynamics in Environmental Systems, John Wiley Sons Inc, 1996.
2. Dunn I.J, Elmar Heinzle, John Ingham, Přenosil J.E, 'Biological Reaction Engineering, ' Wiley inter science, 2005

EV 9153 INDUSTRIAL POLLUTION PREVENTION L T P C
3 0 0 3

UNIT I **9**

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 **9**

Fundamental Rights-Directive principles of state policy-Article 48(A) and 51-A (g) Judicial enforcibility-Constitution and resources management and pollution control-Indian forest policy (1990) –Indian Environmental policy (1992).

UNIT III **9**

Administration 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 madamus and certiorori for pollution abatement-Equitable remedies for pollution control

UNIT IV **9**

Administrative regulation under recent legislations in water pollution control, Water (prevention and control of pollution)Act 1974 as Amended by amendment act 1988 .Water(prevention of control and pollution)Rules1975 Water (prevention and pollution) Cess Act.1977 as amended by amendment act1991.Air(prevention and control of pollution)Act 1981 as amended by Amendment act 1987 and relevant notifications

UNIT V **9**

Relevant notifications in connection with Hazardous Wastes (Management and handling), Biomedical Wastes (Management and Handling), Noise pollution, Eco-labelling, and EIA

TOTAL : 45 PERIODS

REFERENCES

1. Constitution of India Eastern Book Company Lucknow 12th Edition.1997
2. Pandey, J.N., Constitutional Law of India, (31st Edition) Central Law of Agency, Allahabad, 1997
3. Kesari, U.P.D, Administrative Law, Universal Book Trade, Delhi, 1998.
4. Tiwari, H.N., Environmental Law, Allahabad Law.Agency 1997.

EV 9154 ADVANCED OXIDATION PROCESS AND TECHNOLOGY L T P C
3 0 0 3

UNIT I **6**

Introduction to AOP, AOPs for water and wastewater treatment

UNIT II **9**

Photochemical processes of water treatment: photooxidation reactions, photocatalytic reactions, photo-initiated oxidations, heterogeneous and homogeneous photocatalysis, and photolysis of water. UV based application: fundamentals of UV photolysis, UV lamps used in AOP s and their spectral distributions.

UNIT III **9**

Fenton processes: homo and heterogeneous process, effect of system composition and process, identification of degradation products, case studies and applications, semiconductor photolysis: process fundamentals, applications, and commercial process.

UNIT IV **12**

Photoelectrocatalysis process: introduction, photocatalysis, photooxidation and photomineraliztion of organic matter in water and air: aqueous systems, substrate oxidation and mineralization, vaccum-uv oxidation, comparative studies of photo-initiated AOPs, biodegradability and toxicological studies, gaseous systems.Ultrasound process: principles of sonochemistry

UNIT V **9**

Application of AOPs for COD, VOC reduction and odour treatment wastewater from industries like textile, pharmaceutical and petroleum and petrochemical industry.

TOTAL : 45 PERIODS

REFERENCES

1. Simon Parsons, Advanced oxidation processes for water and wastewater treatment, IWA Publishing, 2004
2. Thomas Oppenländer , Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts, Wiley-VCH Publishing, Published by, 2003

EV 9155 **POLLUTION ABATEMENT** **L T P C**
3 0 0 3

UNIT I **9**

Man and environment, types of pollution, pollution controls aspects, industrial pollution, pollution monitoring and analysis of pollutants, Indian pollution regulations.

UNIT II **9**

Water pollution- source of water pollution- measurement of quality- BOD- COD- colour and odor-PH- heavy metals-treatments etc (qualitatively). Industrial waste water treatment (qualitatively) and recycle.

UNIT III **9**

Solid wastes- quantities and characterizations – industrial –hazardous waste- radio active waste- simple treatments and disposal techniques (qualitatively treatment).

UNIT IV **9**

Air pollution-types and sources of gaseous pollutants-particulate matter-hazardous air pollutants-global and atmospheric climatic change (Green house effect)-acid rain. Industrial exhaust –characterization and Methods of decreasing the pollutants content in exhaust gasses (qualitatively)

UNIT V **9**

Noise pollution –sound level-measuring transient noise-acoustic environment-health effects of noise –noise control. Introduction to cosmic pollution

TOTAL : 45 PERIODS

REFERENCE

1. Jeffrey Pierce J, Environmental pollution and control, Butterworth-Heinemann; 4th edn, 1997

EV 9156 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 abalation, magnetron sputtering, electrospinning, Molecular imoring.

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-H_2 storage

UNIT V ENVIRONMENTAL APPLICATIONS **9**

Gas sensors, microfludics and lab on chip, catalytic and photocatalyic applications, Nonmaterials 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, Sysnthesis, Properties and applications. Edited by C.N.R.Rao.
4. Mu”lller, A.K.Cheetham Copyright 8 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim Handbook of Nanotechnology, Edi-Bharat Bhushan, Springer, 2004.

EV 9157 WASTE WATER 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.

EV 9158 ENERGY MANAGEMENT L T P C
3 0 0 3

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 IV **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.

EV 9159 GREEN CHEMISTRY AND ENGINEERING L T P C
3 0 0 3

UNIT I **9**

Overview of Major Environmental Issues, Global Environmental Issues.,Air Quality Issues. Water Quality Issues. Ecology. Natural Resources, Description of Risk. Value of Risk Assessment in the Engineering Profession. Risk-Based Environmental Law. Risk Assessment Concepts. Hazard Assessment. Dose-Response. Risk Characterization.

UNIT II **9**

Pollution Prevention- Pollution Prevention Concepts and Terminology. Chemical Process Safety. Responsibilities for Environmental Protection. Environmental Persistence. Classifying Environmental Risks Based on Chemical Structure. Exposure Assessment for Chemicals in the Ambient Environment.

UNIT III **9**

Green Chemistry. Green Chemistry Methodologies. Quantitative/Optimization-Based Frameworks for the Design of Green Chemical Synthesis Pathways. Green Chemistry Pollution Prevention in Material Selection for Unit Operations. Pollution Prevention for Chemical Reactors. Pollution Prevention for Separation Devices. Pollution Prevention Applications for Separative Reactors. Pollution Prevention in Storage Tanks and Fugitive Sources.

UNIT IV **9**

Process Energy Integration. Process Mass Integration. Case Study of a Process Flow sheet- Estimation of Environmental Fates of Emissions and Wastes.

UNIT V **9**

Magnitudes of Environmental Costs. A Framework for Evaluating Environmental Costs. Hidden Environmental Costs. Liability Costs. Internal Intangible Costs. External Intangible Costs. Introduction to Product Life Cycle Concepts. Life-Cycle Assessment. Life-Cycle Impact Assessments. Streamlined Life-Cycle Assessments. Uses of Life-Cycle Studies.

TOTAL : 45 PERIODS

REFERENCE

1. Allen, D.T., Shonnard, D.R, Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall PTR 2002

EV 9160 ENVIRONMENTAL SUSTAINABILITY L T P C
3 0 0 3

UNIT I **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II **9**

Sustainable Development: Defining the Concept, The Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary-Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCE

1. Andrew Hoffman, Competitive Environmental Strategy -A Guide for the Changing Business Landscape, Island Press.

EV 9161 ENVIRONMENTAL RISK ASSESSMENT L T P C
3 0 0 3

UNIT I **9**

Risk analysis introduction, quantitative risk assessment, rapid risk analysis – comprehensive risk analysis – identification, evaluation and control of risk

UNIT II **9**

Risk assessment – introduction and available methodologies, Risk assessment steps, Hazard identification, Hazard assessment (consequence analysis), probabilistic hazard assessment (Fault tree analysis)

UNIT III **9**

Overall risk contours for different failure scenarios – disaster management plan – emergency planning – onsite and offsite emergency planning, risk management ISO 14000, EMS models – case studies – marketing terminal, gas processing complex.

UNIT IV **9**

Safety measures design in process operations. Accidents modeling – release modeling, toxic release and dispersion modeling, fire and explosion modeling.

UNIT V **9**

Past accident analysis: Fix borough – Mexico – Bhopal analysis. Government policies to manage environmental risk

TOTAL : 45 PERIODS

REFERENCES

1. Crowl,D.A and Louvar,J.F., Chemical process saftery; Fundamentals with applications, prentice hall publication inc., 2002.
2. Khan,F.I and Abbasi,S.A., Risk assessment of chemical process industries; Emerging technologies, Discovery publishing house, New Delhi, 1999.
3. Houstan,H.B., Process safety analysis, Gulf publishing company, 1997.

EV 9162 ECOLOGY AND ENVIRONMENT L T P C
3 0 0 3

UNIT I **10**

Aim - scope and applications of Ecology, Ecological Engineering and Ecotechnology and their relevance to human civilization - Development and evolution of ecosystems - Principles and concepts pertaining to communities in ecosystem - Energy flow and material cycling in ecosystems - Productivity in ecosystems.

UNIT II **10**

Classification of ecotechnology - Principles and components of Systems and Modeling - Structural and functional interactions in environmental systems - Human modifications of environmental systems.

UNIT III **10**

Self organizing processes - Multiple seeded microcosms- Interface coupling in ecological systems - Concept of energy - Adapting ecological engineering systems to potentially catastrophic events - Agro ecosystems - Determination of sustainable loading of ecosystems.

UNIT IV **10**

Principles and operation of soil infiltration systems - wetlands and ponds - source separation systems aqua cultural systems - detritus based treatment for solid wastes - Applications of ecological engineering marine systems.

UNIT V **5**

Case studies of integrated ecological engineering systems

TOTAL : 45 PERIODS

REFERENCES

1. Ignaci Muthu S, 'Ecology and Environment' Eastern Book Corporation, 2007
2. Krebs, Charles J. 2001. Ecology: The Experimental Analysis of Distribution and Abundance. 5th edition.
3. Mitsch, J.W. and Jorgensen, S.E., Ecological Engineering , An Introduction to Ecotechnology, John Wiley & Sons, New York, 1989.

EV 9163 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 (SO_2,SPM,NH_3, H_2S 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.

EV 9164 ENVIRONMENTAL BIOTECHNOLOGY L T P C

3 0 0 3

UNIT I **5**

Principles and concepts of environmental biotechnology - usefulness to mankind.

UNIT II **11**

Degradation of high concentrated toxic pollutants - non-halogenated, halogenated - petroleum hydrocarbons - metals. Mechanisms of detoxification, oxidation reactions, dehalogenation - biotransformation of metals. Microbial cell/enzyme technology - adapted microorganisms - biological removal of nutrients – microalgal biotechnology and applications in agriculture- role of extra cellular polymers.

UNIT III **11**

Biotechnological remedies for environmental damages - decontamination of ground water systems – subsurface environment - reclamation concepts - bioremediation. Production of proteins - biofertilizers. Biodegradation of solid wastes - physical, chemical and microbiological factors of composting - health risk - pathogens – odor management - technologies of commercial importance advances in biogas technology - case study.

UNIT IV **9**

Concept of DNA technology - plasmid - cloning of DNA - mutation - construction of microbial strains.

UNIT V **9**

Environmental effects and ethics of microbial technology - safety of genetically engineered organisms.

TOTAL : 45 PERIODS

REFERENCES

1. Wainwright, M, An Introduction to Environmental Biotechnology, 1999.
2. Martin, A.M., Biological Degradation of Wastes, Elsevier Appl. Science,
3. New York, 1991
4. Gray, S.S., Fox, R and James W. Blackburn Environmental Biotechnology for Waste Treatment, Plenum Press, New York 1991.
5. Rittmann, B.E, Seagren, E., Wrenn, B. A and Valocchi A.J, Ray, C and Raskin, L Insitu Bioremediation (2nd Ed.) Nayes Publ. U.S.A. 1994.
6. Old, R.W., and. Primrose, S.B., Principles of Gene Manipulation (3rd Ed.), Blackwell Sci. Pub, Cambridge, 1985.