UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.E. ENVIRONMENTAL ENGINEERING

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA 9102	Statistics for Environmental Engineers	3	1	0	4
2.	EN 9101	Environmental Chemistry	3	0	0	3
3.	EN 9102	Environmental Microbiology	3	0	0	3
4.	EN 9103	Transport of Water and Wastewater	3	0	0	3
5.	EN 9104	Principles and Design of Physico-Chemical Treatment Systems	3	0	0	3
PRACTICAL						
6.	EN 9105	Environmental Chemistry Laboratory	0	0	3	2
7.	EN 9106	Environmental Microbiology Laboratory	0	0	3	2
		TOTAL	15	1	6	20

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EN 9121	Principles and Design of Biological Treatment Systems	3	0	0	3
2.	EN 9122	Air Pollution Control	3	0	0	3
3.	EN 9123	Solid and Hazardous Waste Management	3	0	0	3
4.	E1	Elective I	3	0	0	3
5.	E2	Elective II	3	0	0	3
PRACTICAL						
6.	EN 9124	Unit Operations and Processes Laboratory	0	0	6	3
		TOTAL	15	0	6	18

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EM 9132	Environmental and Socio-economic Impact Assessment	3	0	0	3
2.	E3	Elective III	3	0	0	3
3.	E4	Elective IV	3	0	0	3
PRACTICALE						
4.	EN 9131	Project Work (Phase-I)	0	0	6	3
5.	EN 9132	Practical Training (4 weeks)	-	-	-	1
6.	EN 9133	Seminar	0	0	2	1
		TOTAL	9	0	8	14

V – SEMESTER

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	EN 9141	Project Work (Phase-II)	0	0	30	15
		TOTAL	0	0	30	15

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 67

ELECTIVES

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	EN 9151	Industrial Wastewater Pollution- Prevention and Control	3	0	0	3
2.	EN 9152	Air and Water Quality Modeling	3	0	0	3
3.	EN 9153	Soil Pollution Engineering	3	0	0	3
4.	EM 9154	Environment, Health and Safety in Industries	3	0	0	3
5.	EN 9154	Environmental Quality Monitoring	3	0	0	3
6.	EM 9156	Remote Sensing and GIS Applications in Environmental Management	3	0	0	3
7.	EM 9157	Climate change and Adaptation	3	0	0	3
8.	EN 9155	Marine pollution and Control	3	0	0	3
9.	EN 9156	Membrane Technologies for Water and Wastewater Treatment	3	0	0	3
10.	EM 9102	Environmental Policies and Legislation	3	0	0	3
11.	EM 9121	Environmental Risk Assessment and Management	3	0	0	3

MA 9102 STATISTICS FOR ENVIRONMENTAL ENGINEERS

L	T	P	C
3	1	0	4

OBJECTIVE:

- To train the students in the analysis of environmental data using statistical tools.

UNIT I EMPIRICAL STATISTICS **9+3**

Types of Sampling – Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT II ESTIMATION THEORY **9+3**

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.

UNIT III TESTING OF HYPOTHESES **9+3**

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS **9+3**

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – latin square design.

UNIT V STATISTICAL QUALITY CONTROL **9+3**

Statistical quality control – Statistical process control – χ and R or S control chart – Attribute control charts – P Chart and U chart – Control chart performance.

TOTAL (L:45+T:15): 60 PERIODS

REFERENCES:

1. Montgomery, D.C. and Runger, G.C., “Applied Statistics and Probability for Engineers”, Wiley Student Edition, 2007.
2. Walpole, R.E., Myers,R.H., Myers,S.L. and Ye K, “Probability and Statistics for Engineers and Scientists” Pearson Education, Asia, 8th edition, 2007.
3. Mann. P.S., “Introductory Statistics”, John Wiley and Sons, Inc 5th edition, 2004.
4. Johnson, R.A. and Gupta, C.B, “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, 7th edition, 2007.

EN 9101	ENVIRONMENTAL CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To educate the students in the area of water, air and soil chemistry and give an exposure in the laboratory for the determination of pollutants.

UNIT I INTRODUCTION 9

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp) ,heavy metal precipitation, amphoteric hydroxides,CO_2 solubility in water and species distribution – Chemical kinetics , First order, Colloids, electrical properties, double layer theory, environmental significance of colloids,coagulation

UNIT II AQUATIC CHEMISTRY 11

Water quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction , Eh – pH diagrams, redox zones, Fe – sorption- Chemical speciation-

UNIT III ATMOSPHERIC CHEMISTRY 7

Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO_2 capture – Acid rain- origin and composition of particulates. Air quality parameters-effects and determination

UNIT IV SOIL CHEMISTRY 9

Nature and composition of soil-Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – Reclamation of contaminated land.

UNIT V EMERGING AREAS 9

Principles of green chemistry, Atom economy, mass index- Nano materials, CNT, titania, composites, environmental applications.

TOTAL: 45 PERIODS

REFERENCES:

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird ‘Environmental Chemistry’, Freeman and company, New York, 1997.
3. Manahan, S.E., Environmental Chemistry, Eighth Edition, CRC press,2005.
4. Ronbald A. Hites ,Elements of Environmental Chemistry, Wiley, 2007.

EN 9102 ENVIRONMENTAL MICROBIOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To educate the students in microbiology and its applications in environmental engineering, and to train them in experiments related to microbiological examination of water.

UNIT I CLASSIFICATION AND CHARACTERISTICS 5

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology.

UNIT II MICROBIOLOGY OF ENVIRONMENT 10

Distribution of microorganisms – Distribution / diversity of Microorganisms – fresh and marine, terrestrial – microbes in surface soil, Air – outdoor and Indoor, aerosols, biosafety in Laboratory – Extreme Environment – archaebacteria – Significance in water supplies – problems and control. Concentration and detection of virus, Transmissible diseases.

UNIT III METABOLISM OF MICROORGANISMS 10

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.

UNIT IV TRANSMISSION OF PATHOGENS AND WASTEWATER TREATMENT 10

Transmission of pathogens – Bacterial, Viral, Protozoan, Indicator organisms of water – Coliforms - total coliforms, E-coli, Streptococcus, Clostridium, Control of microorganisms; Microbiology of biological treatment processes – aerobic and anaerobic, α -oxidation, β-oxidation, nitrification and denitrification, eutrophication.

UNIT V TOXICOLOGY 10

Ecotoxicology – toxicants and toxicity, Factors influencing toxicity. Effects – acute, chronic, concentration response relationships. Test organisms – toxicity testing, Bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring, bioleaching.

TOTAL: 45 PERIODS

REFERENCES:

1. Maier, R.M., I.L. Pepper and C.P. Gerba, 'Environmental Microbiology', Academic Press, New York, 1999.
2. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London (4^{th} Ed), 2002
3. Mcdiagrm, M.T , Martinko J M and Parkn J, Brock Biology of Microorganisms, Printice Hall Int. Inc., India,2003.

EN 9103 TRANSPORT OF WATER AND WASTEWATER

L	T	P	C
3	0	0	3

OBJECTIVES:

- To educate the students in detailed design concepts related to water transmission mains, water distribution system, sewer networks and storm water drain, with emphasis on computer application.

UNIT I GENERAL HYDRAULICS AND FLOW MEASUREMENT 8

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying Capacity–Flow measurement.

UNIT II WATER TRANSMISSION AND DISTRIBUTION 10

Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection Storage reservoirs.

UNIT III WASTEWATER COLLECTION AND CONVEYANCE 10

Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.

UNIT IV STORM WATER DRAINAGE 7

Necessity- - combined and separate system; Estimation of storm water run off Formulation of rainfall intensity duration and frequency relationships- Rational methods

UNIT V CASE STUDIES AND SOFTWARE APPLICATIONS 10

Use of computer software in water transmission, water distribution and sewer design – LOOP version 4.0, SEWER, BRANCH, Canal ++ and GIS based softwares.

TOTAL: 45 PERIODS

REFERENCES:

1. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2003
2. “Manual on water supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. “Manual on Sewerage and Sewage Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.

EN 9104 PRINCIPLES AND DESIGN OF PHYSICO-CHEMICAL TREATMENT SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To educate the students on the working principles and design of various physical and chemical treatment systems for water and wastewater.

UNIT I CLASSIFICATION OF POLLUTANTS 5

Pollutants in water and wastewater – characteristics, Standards for performance Significance of physico-chemical treatment – Selection criteria-types of reactor- reactor selection-batch-continuous type-kinetics

UNIT II PHYSICAL TREATMENT PRINCIPLES 8

Principles of Screening – Mixing, Equalization – Sedimentation – Filtration – Modeling back washing – Evaporation – Incineration – gas transfer – mass transfer coefficient Adsorption – Isotherms – Principles, kinetics, regeneration membrane separation, Reverse Osmosis, nano filtration, ultra filtration and hyper filtration electrodialysis, distillation – stripping and crystallization – Recent Advances.

UNIT III CHEMICAL TREATMENT PRINCIPLES 7

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

UNIT IV DESIGN OF MUNICIPAL WATER TREATMENT PLANTS 15

Selection of Treatment – Design of municipal water treatment plant units – Aerators – chemical feeding – Flocculation – clarifies – tube settling – filters – Rapid sand filters slow sand filter, pressure filter, Dual media inlets Displacement and gaseous type. Design of Industrial Water Treatment Units- Selection of process – Design of softeners – Demineralisers –Reverse osmosis plants –flow charts – Layouts –Hydraulic Profile PID construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends – Software application.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 10

Design of municipal wastewater treatment units-screens-detritors-grit chamber-settling tanks-sludge thickening-sludge dewatering systems-sludge drying beds - Design of Industrial Wastewater Treatment Units-Equalization- Neutralization-Chemical Feeding Devices-mixers-floatation units-oil skimmer- flow charts – Layouts –Hydraulic Profile PID construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends – Software application.

TOTAL: 45 PERIODS

REFERENCES:

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
2. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
3. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
4. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York, 2006.

EN 9105 ENVIRONMENTAL CHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

OBJECTIVE:

- To train in the analysis of physico-chemical parameters with hands on experience of various sources.

1.	Good Laboratory Practices, Quality control, calibration of Glassware	**3**
2.	Sampling and Analysis of water (pH, alkalinity, hardness chloride, sulphate turbidity EC, TDS, nitrate, fluoride)	**12**
3.	Wastewater analysis (BOD, COD, Phosphate, TKN, Oil & Grease, Surfactant and heavy metals.	**12**
4.	Sampling and analysis of air pollutants Ambient & Stack (SPM, RPM, SO_2, NOx and CO)	**9**
5.	Sampling characterization of soil. (CEC & SAR, pH, heavy metals).	**9**

TOTAL: 45 PERIODS

REFERENCES:

1. APHA, Standard Methods for the Examination of Water and Wastewater, 21st Ed. Washington, 2005.
2. Laboratory Manual for the Examination of water, wastewater soil Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 1992.
3. Methods of air sampling & analysis ,James P.Lodge Jr(Editor) 3rd Edition, Lewis publishers,Inc,USA,1989.

EN 9106 ENVIRONMENTAL MICROBIOLOGY LABORATORY L T P C
0 0 3 2

OBJECTIVE:

- To train in the analysis of biological parameters with hands on experience of various sources.

1. Preparation of media,
2. Isolation and Identification of Microorganisms
3. Culturing of microorganisms,
4. Dehydrogenase activity of soil microbes,
5. Degradation of 2, 4-D,
6. Biodegradation of organic matter in waste water Analysis of air borne microorganisms,
7. Measurement of growth of microorganisms,
8. Staining of bacteria.
9. Effect of pH, temperature
10. Growth of Bacteria on carbon source.
11. Bacteriological analysis of wastewater (Coliforms, E-Coli, Streptococcus) – MPN
12. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques,
13. Microscopic study of phyto & Zooplankton,
14. Metal toxicity to microorganisms.
15. Detection of Anaerobic bacteria (clostridium sp.)

TOTAL: 45 PERIODS

REFERENCES:

1. Standard methods for the examination of water and wastewater, American public health Association (21st edition) 2005.
2. Pepper. L and Charles P. Gerba, Environmental Microbiology: A laboratory manual, Elsevier Publications, 2004.

EN 9121 PRINCIPLES AND DESIGN OF BIOLOGICAL TREATMENT SYSTEM

L	T	P	C
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.

EN 9122 AIR POLLUTION CONTROL

L	T	P	C
3	0	0	3

OBJECTIVE:

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

UNIT I INTRODUCTION 7

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards – Air Pollution Indices – Emission Inventories – Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

UNIT II METEOROLOGY 5

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Software application, Plume rise, Effective stack height .

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators (cyclone) , Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations - Process Control and Monitoring – Costing of APC equipment – Case studies for stationary and mobile sources.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations - Costing of APC Equipment – Case studies for stationary and mobile sources.

UNIT V INDOOR AIR QUALITY MANAGEMENT 11

Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control – Membrane process - UV photolysis – Internal Combustion Engines - Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL: 45 PERIODS

REFERENCES:

1. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Air Pollution Control Engineering, Tokyo, 2004.
2. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York, 1995.
3. David H.F. Liu, Bela G. Liptak 'Air Pollution', Lweis Publishers, 2000.
4. Anjaneyulu. Y, 'Air Pollution and Control Technologies', Allied Publishers (P) Ltd., India, 2002.
5. Arthur C.Stern, ' Air Pollution (Vol.I – Vol.VIII)', Academic Press, 2006.
6. Wayne T.Davis, 'Air Pollution Engineering Manual', John Wiley & Sons,Inc.,2000.

EN 9123 SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

- To impart knowledge on the elements of managing solid wastes from Municipal and industrial sources including the related engineering principles, design criteria, methods and equipments.

UNIT I SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK 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, electronic wastes , plastics and fly ash – Financing waste management.

UNIT II WASTE CHARACTERIZATION AND SOURCE REDUCTION 8

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 –Waste exchange - Extended producer responsibility - Recycling and reuse

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 10

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 – Rehabilitation of open dumps – landfill remediation

TOTAL: 45 PERIODS

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.
3. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2000.
4. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.

EN 9124 UNIT OPERATIONS AND PROCESSES LABORATORY

L	T	P	C
0	0	6	3

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.

EM 9132 ENVIRONMENTAL AND SOCIO ECONOMIC IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

- To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.

UNIT I INTRODUCTION 7

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in EIA. Eia process-screening – scoping - setting – analysis – mitigation

UNIT II COMPONENTS AND METHODS FOR EA 10

Matrices – Networks – Checklists – Connections and combinations of processes - Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological –– Cumulative Impact Assessment – Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation. EIA methods in other countries.

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Definition of social impact assessment. Social impact assessment model and the planning process. Rationale and measurement for SIA variables. Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition - neighborhood and community impacts. Selecting, testing and understanding significant social impacts. Mitigation and enhancement in social assessment. Environmental costing of projects.

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 SECTORAL EIA 10

EIA related to the following sectors - Infrastructure –construction and housing Mining – Industrial - Thermal Power - River valley and Hydroelectric – coastal projects-Nuclear Power. EIA for coastal projects.

TOTAL: 45 PERIODS

REFERENCES:

1. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
2. World Bank –Source book on EIA
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999.
4. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996

EN 9151 INDUSTRIAL WASTEWATER POLLUTION -PREVENTION AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVE:

- To provide knowledge on sources and characteristics of industrial wastewater, techniques and approaches for minimizing the generation and application of physio chemical and biological treatment methods for recovery, reuse and disposal supported with case studies under Indian situations.

UNIT I INTRODUCTION 8

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management

UNIT II INDUSTRIAL POLLUTION PREVENTION 8

Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options –Cost benefit analysis – pay back period - Waste minimization Circles

UNIT III INDUSTRIAL WASTEWATER TREATMENT 10

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

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT 9

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - 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 10

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries.

TOTAL: 45 PERIODS

REFERENCES:

1. Eckenfelder, W.W., 'Industrial Water Pollution Control', Mc-Graw Hill, 2000.
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.

EN 9152 AIR AND WATER QUALITY MODELING

L	T	P	C
3	0	0	3

OBJECTIVE:

- This course introduces the basic concept of mathematical modeling and process simulation techniques of environmental disturbances with reference to air, water and groundwater domains.

UNIT I MODELING CONCEPTS 12

Casual and statistical models-Characteristics- Steps in model development - Importance of model building.- conservation of mass and mass balance –calibration and verification of models; Transport phenomena – Advection, diffusion, dispersion, simple transport models; chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

UNIT II WATER QUALITY MODELING 10

Water quality models – Historical development – Mass balance equation – Streeter - Phelps Equation – Modification to Streeter – Phelps Equation – Waste load allocations – Dissolved oxygen in Rivers and estuaries; Lake Water Quality Models; Models for Nitrogen, Bacteria, Phosphate and toxicants - Ground Water Quality Modeling - Contaminant solute transport equation, Numerical methods.

UNIT III AIR POLLUTION MODELING 9

Chemistry of air Pollutants - Atmospheric reactions, sinks for air pollution –Transport of air Pollutants - Meteorological settling for dispersal of air pollutants – Vertical structure of temperature and stability, atmospheric motions, Wind and shear, self cleaning of atmosphere; transport and diffusion of stack emissions – atmospheric characteristics significant to transport and diffusion of stack emission – stack plume characteristics.

UNIT IV AIR QUALITY MODELS 9

Types modeling technique, modeling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Fixed box models- diffusion models – Gaussian plume derivation- modifications of Gaussian plume equation- long term average-multiple cell model- receptor oriented and source oriented air pollution models-model performance, accuracy and utilization.

UNIT V APPLICATIONS 5

Software package applications: Air quality modeling and water quality modeling.

TOTAL: 45 PERIODS

REFERENCES:

1. Steven C.Chapra, Surface Water Quality Modelling, The McGraw-Hill Companies, Inc., New Delhi, 1997.
2. J.L.Schnoor, Environmental Modeling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.
3. Air Pollution (Third Ed.) Volume I – Air Pollutants, their transformation and Transport, (Ed.) Arthur C.Stern, Academic Press, 2006.
4 Deaton and Wine Brake, “Dynamic Modeling of Environmental Systems”, Wiley & Sons, 2002.

EN 9153 SOIL POLLUTION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- The student acquires the knowledge on problem associated with soil contamination, safety disposal of waste and remediate the contaminated soils by different techniques thereby protecting environment.

UNIT I PHYSICS AND CHEMISTRY OF SOIL 8

Soil formation – composition – soil fabric – mass-volume relationship – Index properties and soil classification – hydraulic and consolidation characteristics – Chemical properties – soil pH – Surface charge and point of zero charge – Anion and Cation exchange capacity of clays– Specific surface area- bonding in clays-soil pollution-factors governing soil-pollutant interaction.

UNIT II INORGANIC AND ORGANIC GEOCHEMISTRY 9

Inorganic geochemistry – Metal contamination – Distribution of metals in soils – Geochemical processes controlling the distribution of metals in soils – Chemical analysis of metal in soil – Organic geochemistry – Organic contamination – Distribution of NAPLs in soils – Process controlling the distribution of NAPLs in soil – Chemical analysis of NAPLs in soils.

UNIT III CONTAMINANT FATE AND TRANSPORT IN SOIL 9

Transport processes – advection – diffusion – dispersion – chemical mass transfer processes – sorption and desorption – precipitation and dissolution – oxidation and reduction – acid base reaction – complexation – ion exchange – volatilization – hydrolysis – biological process-microbial transformation of heavy metals.

UNIT IV GROUND IMPROVEMENT TECHNIQUES IN WASTE MANAGEMENT 9

Role of Ground Improvement-Drainage and Ground Water Lowering-Electro osmotic Methods-Diaphragm walls-Thermal and Freezing methods - Insitu Densification - Deep Compaction -Dynamic Compaction -Blasting Sand piles pre-loading with sand drains-Stone Columns Lime piles- Earth reinforcement -rock bolts Cables and guniting Geotextiles as reinforcement Filtration. Drainage and Erosion control.

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.

EM 9154 ENVIRONMENT, HEALTH AND SAFETY IN INDUSTRIES **L T P C**
3 0 0 3

OBJECTIVE:

- To educate about the health hazards and the safety measures to be followed in the industrial environment.

UNIT I INTRODUCTION **9**

Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE **9**

Definition of the term occupational health and hygiene. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS **9**

Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

UNIT IV TECHNIQUES OF ENVIRONMENTAL SAFETY **9**

Elements of a health and safety policy and methods of its effective implementation and review. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Industry specific EHS issues.

UNIT V EDUCATION AND TRAINING **9**

Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

TOTAL: 45 PERIODS

REFERENCES:

1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
2. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
3. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005

EN 9154	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

REFERENCES:

1. Willard H. Merritt, L. Dean, D.A. and Settle, F.A. 'Instrumental methods of analysis Edn. Words Worth, New York, 2004.
2. Paul R. Loconto Trace Environmental Quantitative Analysis: Principles, Techniques, and Applications**,** Marcel Dekker; 1 edition (May 2001),
3. Ewing Instrumental Methods of Chemical Analysis, 5th Edition, McGraw Hill, New York.1985
4. Reeve, R.N., "Introduction to Environmental Analysis", Analytical Techniques in the Sciences, John Wiley & Sons, Chichester, UK, 2002.
5. Barceló, D.(editor), "Environmental analysis. Techniques, Applications and Quality Assurance", Elsevier, The Netherlands, 1996

EM 9156 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT

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.

EM 9157 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 IMPACTS OF CLIMATE CHANGE 9

Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions– Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.

UNIT IV CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES 9

Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry – Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS)- Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.

UNIT V CLEAN TECHNOLOGY AND ENERGY 9

Clean Development Mechanism –Carbon Trading- examples of future Clean Technology – Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.

TOTAL: 45 PERIODS

REFERENCES:

1. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003
2. Al core 'inconvenient truth" – video form
3. IPCC Fourth Assessment Report – The AR4 Synthesis Report,
4. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007

EN 9155	MARINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand the Coastal and Marine Systems and the sources of pollution and methods for monitoring, modeling and control.

UNIT I COASTAL ENGINEERING 6

Introduction to the coastal features – Beaches, Estuaries, Lagoons – Principles of Marine Geology – Sea water Classification -The oceans and climate

UNIT II WAVE HYDRODYNAMICS 10

Wave Theory, Waves in shallow waters – Refraction, Diffraction and Shoaling, Approximations for deep and shallow water conditions – Tidal Classification - General circulation of ocean waters - Ocean currents - Coastal sediment transport - Onshore offshore sediment transport - Beach formation and coastal processes - Tsunamis, storm surge, El Niño effect - Physical modeling in Coastal Engineering

UNIT III MARINE POLLUTION SOURCES AND EFFECTS 8

Sources of Marine Pollution – Point and non-point sources, Pollution caused by Oil Exploration, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems – Marine discharges and effluent standards

UNIT IV MONITORING AND MODELLING OF POLLUTION 12

Basic measurements - Sounding boat, lead lines, echo sounders – current meters - tide - use of GPS – Measurement of coastal water characteristics – sea bed sampling – Modelling of Pollutant transport and dispersion - Oil Spill Models - Ocean Monitoring satellites – Applications of Remote Sensing and GIS in monitoring marine pollution - Risk Assessment

UNIT V MARINE POLLUTION CONTROL 9

Coastal Zone Regulation – Total Maximum Daily Load applications – Design of out falls- Pollution Control strategies – Selection of optimal Outfall locations - National and International Treaties, Protocols in Marine Pollution – ICZM and Sustainable Development

TOTAL: 45 PERIODS

REFERENCES:

1. Marine Pollution (5th Edition) R.B. Clark, C. Frid and M Atttrill Oxford Science Publications, 2001
2. Marine pollution Dr.P.C.Sinha , Anmol Publications Pvt. Ltd, 1998.
3. Problems of Marine Pollution : India and Canada, Raghavan, Sudha , Eastern Book Corporation, Delhi, India,
4. Laws, E.A., Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 2000.

EN 9156 MEMBRANE TECHNOLOGIES FOR WATER AND WASTEWATER TREATMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

- To introduce the concept and principles of membrane separation and its applications in water and wastewater treatment.

UNIT I INTRODUCTION **10**

Solid Liquid separation systems-Filtration systems- Theory of Membrane separation – mass Transport Characteristics Cross Flow filtration-Membarne Filtration- Types and choice of membranes, porous, non porous, symmetric and assymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

UNIT II MEMBRANE PROCESSES AND SYSTEMS **10**

Microfiltration – Ultrafiltration- Nano Filtration – Reverse Osmosis – Electro dialysis- Pervaporation -Membrane manufatures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection – Plant operations – Economics of Membrane systems

UNIT III MEMBRANE BIOREACTORS **9**

Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

UNIT IV PRETREATMENT SYSTEMS **8**

Membrane Fouling – Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning , Biofoulant control

UNIT V CASE STUDIES **8**

Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants

TOTAL: 45 PERIODS

REFERENCES:

1. Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005
2. Symon Jud, MBR Book – Principles and application of MBR in water and wastewater treatment, Elservier, 2006
3. K. Yamamoto and Urase T, Membrane Technology in Environmental management, special issue, Water Science and technology, Vol.41, IWA Publishing, 2000
4. Jorgen Wagner, Membrane Filtration handbook, Practical Tips and Hints, Second Edition, Revision2, Osmonics Inc., 2001
5. Mulder, M., Basic Principle of Membrane Technology, Kluwer Academic Publishers, 1996
6. Noble, R.D. and Stern, S.A., Membrane Separations Technology: Principles and Applications, Elservier, 1995

EM 9102 ENVIRONMENTAL POLICIES AND LEGISLATION L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.

UNIT I INTRODUCTION 9

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

UNIT II WATER (P&CP) ACT, 1974 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III AIR (P&CP) ACT, 1981 8

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV ENVIRONMENT (PROTECTION) ACT 1986 13

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V OTHER TOPICS 7

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC - Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

TOTAL: 45 PERIODS

REFERENCES:

1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz “Environmental law and policy in India “Oxford University Press, New Delhi, 2001.
3. Greger I.Megregor, “Environmental law and enforcement”, Lewis Publishers, London. 1994.

EM 9121 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.