M.Tech. (ENVIRONMENTAL ENGINEERING)

CURRICULUM AND SYLLABUS

(Effect from the Academic Year 2007 – 08)

PONDICHERRY UNIVERSITY
PUDUCHERRY – 605014.

M.TECH. (ENVIRONMENTAL ENGINEERING)
COURSE CURRICULUM AND SCHEME OF EXAMINATION

(Minimum Credit Requirement for the completion of the Programme: 72)

ELIGIBILITY:

M.Tech. (Environmental Engineering): Candidates for admission to the first semester of the four semester M.Tech. Course in Environmental Engineering should have passed B.E/B.Tech in Civil/Chemical Engineering or an examination of any University or Authority accepted by the Pondicherry University as equivalent thereto, with at least 55% marks in the degree examination or equivalent CGPA.

SEMESTER – I

Sl. No	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	CE 911	Mathematics for Environmental Engineers	3	1	0	4	40	60	100
2.	CE 912	Environmental Chemistry	3	1	0	4	40	60	100
3.	CE 913	Environmental Microbiology	3	1	0	4	40	60	100
4.	CE 914	Unit Operations and Processes in Water and Wastewater Treatment	3	1	0	4	40	60	100
5.		Elective – I	3	0	0	3	40	60	100
6.	CE 917	Laboratory and Field Testing	1	0	3	2	50	50	100
						21	250	350	600

SEMESTER – II

Sl. No	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	CE 915	Design and Operation of Water and Wastewater Treatment Plants	3	1	0	4	40	60	100
2.	CE 916	Transport of Water and Wastewater	3	1	0	4	40	60	100
3.		Elective – II	3	0	0	3	40	60	100
4.		Elective – III	3	0	0	3	40	60	100

5.		Elective –IV	3	0	0	3	40	60	100
6.		Elective – V	3	0	0	3	40	60	100
7.	CE 918	Seminar	0	0	3	2	100	-	100
						22	340	360	700

S**EMESTER – III**

Sl. No	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.		Elective – VI	3	0	0	3	40	60	100
2.		Elective – VII	3	0	0	3	40	60	100
3.	CE 971	Directed Study	0	0	6	3	100	---	100
4.	CE 919	Dissertation Project (Phase I)	0	0	24	8	200	100	300
						17	380	220	600

SEMESTER – IV

Sl. No	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	CE 920	Dissertation Project (Phase II)	0	0	36	12	250	150	400
						12	250	150	400

ELECTIVE SUBJECTS

Sl.No.	Code	Subject	Credits
1.	CE 941	Air and Water Quality Modelling	3
2.	CE 942	Air Pollution Control	3
3.	CE 943	Cleaner Production	3
4.	CE 944	Ecological Engineering	3
5.	CE 945	Environmental Biotechnology	3
6.	CE 946	Environmental Geotechnology	3
7.	CE 947	Environmental Impact Assessment	3
8.	CE 948	Fundamentals of Sustainable Development	3
9.	CE 949	Industrial Wastewater Management	3
10.	CE 950	Instrumental Monitoring of Environment	3
11.	CE 951	Principles of Environmental Science	3
12.	CE 952	Remote Sensing and GIS Applications in Environmental Engineering	3
13.	CE953	Solid and Hazardous Waste Management	3

CE 911 MATHEMATICS FOR ENVIRONMENTAL ENGINEERS

1. **Statistical Methods:**
   Measures of Central tendency, dispersion, skewness and kurtosis- Principles of least squares – Correlation and regression – rank correlation.

2. **Sampling Distributions and Estimation**
   Sampling distribution- point and interval estimates for population proportions, mean and variance- one- way and two – way classification.

3. **Test of hypothesis of Small Samples:**

   Sampling Distributions - t, chi-square and F distribution .

4. **Test 0f Hypothesis of Large Sample:**
   Test based on Normal distribution, Analysis of variance-one-way and two-way classification.

5. **Linear Programming Methods**
   Basic concepts – Graphical, Simplex, Big M and Two Phase methods – Transportation problem - Assignment problem.

References:

1. Freund, J.E. and Miller,I.R., “Probability and Statistics for Engineers”, Prentice – Hall of India,5th Edition, New Delhi,1994.

2. Gupta, S.C. and Kapur, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 1999.

3. Taha, H.A., “Operations Research: An Introduction”, Prentice – Hall of India, 6th Edition, New Delhi, 1997.

4. Kapoor.V.K., ”Problems and Solutions in Operations Research”, Sultan Chand & Sons, New Delhi,1997.

CE 912 ENVIRONMENTAL CHEMISTRY

1. **Principles of Physical Chemistry:**

Reversible reactions, equilibrium constant, Le-Chatelier principle. Reaction rate Order and molecularity, kinetic equations of different orders, reversible and consecutive reactions. Catalysis-type, characteristics , activation energy, mechanism of catalyst action, acid base catalysts. Photo catalysis. Adsorption-classification, adsorption of gases on solids, adsorption from solutions, ion exchange adsorption, applications, Longmuir theory

2. **Principles of Aquatic Chemistry and BioChemsitry**

Water resources, sea water- composition, Ph of sea water. Humic substances. Aquatic chemical reactions- microbial redox reaction, iron and manganese bacteria, nitrogen transformation bacteria. Enzymes-mechanism and factors influencing enzyme action. Biodegradation- biodegradation of carbohydrates, proteins , fats and oils and detergents. Colloidal state- stability, kinetic, optical and electrical properties

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3. **Environmental Chemicals**

Chemical speciation – speciation of lead, mercury, arsenic and chromium. Structure and property- activity relationship, fate of organics in the environment – transformation reactions- hydrolysis, elimination, oxidation, reduction and photochemical transformation. Risk evaluation of environmental chemicals, Toxic chemicals in the environment, impact on enzymes. Biochemical effects of arsenic, lead, mercury and pesticides

4. **Atmospheric Chemistry**

Structure of atmosphere, chemical and photochemical reactions in the atmosphere. Ozone chemistry- formation and depletion of zone layer, oxides of nitrogen and sulphur. Acid rain mechanism of formation and effects. Photochemical smog, and sulfurous smog. Green house effect/global warming, green house gases, effects

5. **Fundamentals of analytical Principles**

Analysis of water and water quality parameters -concept of pH, measurement of acidity, alkalinity, hardness, residual chlorine, chlorides, DO, BOD, COD, fluoride and nitrogen. Introduction to spectral analysis, colorimetry, fluorimety, nephlometry, turbidimetry, absorption and emission spectral methods.

References:

1. C.N Sawyer, P.L McCarty and G.F Parkin, Chemistry for Environmental Engineering and Science, 5th ed. Tata McGraw-Hill, 2003
2. B.S Bhal, GD Tuli and Arun Bhal, Essentials of Physical Chemistry, S. Chand & Co Ltd. New Delhi, 2003
3. Arun Kumar De, Environmental Chemistry, 5th ed, New Age International (P) Ltd, New Delhi

CE 913 ENVIRONMENTAL MICROBIOLOGY

1. Introduction:

Microorganisms – classification, prokaryotic and eukaryotic cells, structure, characteristics, nucleic acids, DNA and RNA, replication, Recombinant DNA – Genetic Engineering.

2. Microbial growth and Metabolism

Environmental factors, nutrition and metabolism, growth phases, enzymes, carbohydrate, protein, lipids metabolism, respiration, fermentation, Glycolysis, Kreb's cycle, Hexose monophosphate pathway, significance of energetics.

3. Microbiology of Drinking water:

Distribution of microorganisms, indicator organisms, coliforms – fecal coliforms – E.coli, Streptococcus fecalis and Clostridium welchii, differentiation of coliforms – significance – MPN index, M.F. technique, standards. Virus-concentration techniques. Algae in water supplies – problems and control.

4. Microbiology of Toxic Wastewater Treatment

Biodegradation of toxic pollutants – alpha oxidation, beta-oxidation, electrons transport system and oxidative phosphorylation mechanism, Microbiology of biological treatment process.

5. Aquatic Microbiology

Ecotoxicology – toxicants and toxicity – factors influencing toxicity, effects, acute, chronic, concentration response relationships, test organisms, toxicity testing bioconcentration – bioaccumulation – bio-magnification – bioassay – biomonitoring.

References:

1. Pelczar, Jr, M.J., Chan E.C.S., Krieg, R.Noel., and Pelczar Merna Foss, Microbiology, 5th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.

2. Stainer, R.Y., Ingrahum, J.L., Wheelis, M.C. and Painter, P.R. General Microbiology, Mac Millan Edition Limited, London, 1989.

3. Pichai, R. and Govindan, V.S., Edition, Biological processes in pollution control Anna University, Madras, 1988.

CE 914 UNIT OPERATIONS AND PROCESSES IN WATER AND WASTEWATER TREATMENT

1. **Fundamental Physical Unit operations:**

   Factors in selection of unit operations and processes – Principal type of Reactors – Flow measurement – Screening – Flow Equalisation – Mixing – static and Mechanical mixers – Coagulation and Flocculation – Perikinetic and Orthokinetic flocculation.

2. **Principles of Sedimentation and Floatation:**

   Sedimentation – Type of setting – Removal ratio – Tray and Titles plate settlers Floatation - Dissolved air flotation.

3. **Filtration and Gas Transfer:**

   Filtration – Type of filters – Head loss through filters – Carment-Kozeny equation – Gas Transfer – Two film Theory – Mass transfer – Oxygenation capacity.

4. **Chemical Unit Processes:**

   Chemical precipitation – phosphate removal – Adsorption – Activated carbon – Isotherms – Disinfection – principles – types of chlorination – Dechlorination.

5. **Biological Unit Processes:**

   Kinetic principles of Biological growth – Suspended and attached growth processes – Aerobic and Anaerobic – Determination of kinetic coefficients.

References:

1. METCALF & EDDY, INC. 'Wastewater Engineering, Treatment, Disposal, and Reuse. Fourth Edition, Tata McGraw-Hill Publishing company Limited, New Delhi, 2002.

2. CASEY. T.J. "Unit Treatment Processes in Water and Wastewater Engineering", John Wiley & Sons, England, 1993.

CE 915 DESIGN AND OPERATION OF WATER AND WASTEWATER TREATMENT PLANTS

1. **Water Treatment:**
   Design of conventional water treatment units – Aeration, chemical dosing tanks, Flash mixers, Flocculators, Sedimentation tanks, Clariflocculators, filter beds, disinfection units – hydraulic profile and layout of conventional treatment units – upgrading of existing plants – Residue management.

2. **Wastewater Treatment:**
   Design of sewage treatment plant units – screen chamber, Grit chamber with proportional flow weir, sedimentation tank, Trickling filters (standard rate, high rate), Rotating Biological contactor, activated sludge process, oxidation ditches, aerated lagoons, waste stabilisation ponds – hydraulic profile and layout of primary and secondary nits – Anaerobic treatment systems, septic tank and disposal system, Sludge management, Sludge thickening, sludge digestion, sludge dewatering (mechanical and gravity) – Upgrading existing plants – Ultimate residue disposal.

3. **Industrial water Treatment:**
   Design of softening plants, Demineralisers, Desalination plants, Boiler feed water treatment – Residue management.

4. **Operation, Maintenance and Management:**
   Operational problems – Trouble shooting, Planning, Organising and Controlling of plant operations – Training of operation personnel.

5. **Case Studies:**
   Conventional water and sewage treatment plants – Industrial water treatment plants – Sludge treatment facilities – Wastewater reclamation plants – Field visits.

References:

1. Manual on “Water Supply and Treatment” CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
2. Manual on “Sewerage and Sewage Treatment” CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
3. METCALF & EDDY, INC. ‘Wastewater Engineering, Treatment, Disposal and Reuse. Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.

CE 916 TRANSPORT OF WATER AND WASTEWATER

1. **Fundamental Hydraulics:**

   Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, major and minor head loss, formula for estimation of head loss – pumping of fluids – selection of pumps – Flow measurement.

2. **Water Transmission and Distribution:**

   Planning factors – Water transmission main design – pipe material – economics; water distribution pipe networks – methods for analysis and optimization – Laying and maintenance, insitu lining – appurtenances – corrosion prevention.

3. **Wastewater Collection and Conveyance:**

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

4. **Storm Water Drainage:**

   Planning – run-off estimation, rainfall data analysis, storm water drain design-rainwater harvesting.

5. **Software Applications:**

   Use of computer software in water transmission, water distribution and sewer design – LOOP version 4.0, SEWER, BRANCH.

References:

1. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
2. "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
3. B.A. Hauser, Practical Hydraulics Hand Book, Lewis Publishers, New York, 1991.
4. M.J. Hammer, Water and Wastewater Technology, Regents/Prentice Hall, New Jersey, 1991.

CE-917 LABORATORY AND FIELD TESTING

1. Chemistry Laboratory practice:

Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods – Sampling and analysis of ambient air for SPM, SO_2, Oxides of nitrogen – Good laboratory practice – Analytical quality control

2. Microbiology Laboratory Practicals

Media preparation and inoculation – staining – environmental factors – bacteriological analysis of water, sewage, test for plate count – coliforms – fecal coliforms – E.coli – S.fecalis – M.P.N. and M.F. techniques. Techniques for studying aquatic organisms – identification of phytoplankton and zooplankton – bioassay study and biodegradation.

References:

1. Sawyer, C.N. and McCarty, P.L. and Parkin, G.F. "Chemistry for Environmental Engineers", 4th Edition, McGraw Hill, New Delhi, 1994.

2. De.A.K. "Environmental Chemistry ", New Age International Ltd., New Delhi, 1995.

3. "Standard Methods for the Examination of Water and Wastewater", 20th Edition, American Public Health Association, Washington. D.C. 1998.

CE 918 SEMINAR

Each candidate is required to give one seminar on any chosen topic connected with the field of specialisation. The topic shall be chosen in consultation with the concerned Faculty and Head of the Department. Preparation and presentation of a seminar is intended to investigate an indepth review of literature; to prepare a critical review and to develop confidence for making a good presentation. A report has to be submitted in the prescribed format and the seminar shall be evaluated by the respective department committee.

CE 919 DISSERTATION PROJECT -PHASE I

It will be taken up by the student at the end of the second semester and the duration would be six months. This is aimed at training the students to analyse independently any problem posed to them. The work may be analytical, experimental, design or combination of these. The dissertation report is expected to exhibit clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill. The evaluation of dissertation will be based on continuous internal assessment comprising three seminars, one internal Viva-voce and an external Viva-voce examination.

CE 920 DISSERTATION PROJECT -PHASE II

It is the continuation of the Dissertation Project -Phase I. The Dissertation report is to be submitted at the end of the fourth semester. The evaluation of dissertation will be based on continuous internal assessment comprising three seminars, one internal Viva-voce and an external Viva-voce examination.

CE 949 INDUSTRIAL WASTEWATER MANAGEMENT

1. **Introduction:**

   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.

2. **Industrial Wastewater Treatment:**

   Equalisation – Neutralisation – Oil separation – Floatation – Precipitation – Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors, reed bed technology, low cost treatment methods

3. **Advanced Wastewater Treatment and Reuse:**

   Chemical oxidation – Ozonation – Photo catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal – waste Land Treatment.

4. **Residual Management:**

   Residuals of industrial wastewater treatment – Qualification and characteristics of Sludge –solids reduction, Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

5. **Case Studies:**

   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.

References:

1. Eckenfelder, W.W., (2000)'Industrial Water Pollution Control", Mc-Graw Hill.
2. Arceivala, S.J., (1998) 'Wastewater Treatment for Pollution Control', Tata Mc-Graw Hill
3. World Bank Group (1998) 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production', World Bank and UNEP, Washington D.C.

CE 947 ENVIRONMENTAL IMPACT ASSESSMENT

1. Introduction:

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 of EIA – National – cross
sectoral – social and cultural.

2. Components and Methods:

Components – screening – setting – analysis – prediction of impacts – mitigation. Matrices – Networks – Checklists. Importance assessment techniques – cost benefit analysis – analysis of alternatives – methods. 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.

3. Quality Control:

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

4. **Documentation and Monitoring:**

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

5. **Case Studies:**

Case studies of EIA of developmental projects.

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.

CE 942 AIR POLLUTION CONTROL

1. Introduction:

Sources and classification of Air Pollutants: Natural contaminants-aerosol – gases and vapour. Air quality standards – Meteorology and Air Pollution: Atmospheric stability and inversions-mixing height-plume rise estimation – effluent dispersion theories - Isokinetic sampling – Modelling.

2. Control of Particulars:

Objectives – Filters, gravitational, centrifugal – multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory-particle charging-particle collection –ESP design procedure.

3. Gaseous Pollutant Control:

Absorption: principles, description of equipment-packed and plate columns, design and performance equations. Adsorption: principal adsorbents, equipment descriptions – PSA – adsorption cycle-solvent recovery system-continuous rotary bed-fluidized bed, Design and performance equations. Condensation: contact condensers-shell and tube condensers, design and performance equation. Incinertion: hydrocarbon incinertion kinetis, equipment description, design and performance equations.

4. Control Measures for Industrial Applications:

Control methods – Processes based control mechanisms – mineral products – asphaltic concrete, cement plants and glass manufacturing plants; Thermal power plants, Petroleum refining and storage plants, Fertilizers, Pharmaceuticals and wood processing industry. Field Study.

5. Noise Control:

Noise Standards; measurement, control and preventive measures.

References:

1. Richard W. Boubel et al “Fundamentals of Air pollution”, Academic Press, New York, 1994.
2. Noel de Nevers, Air Pollution control Engineering, McGraw Hill, New York, 1995.
3. M.N. Rao et al, “Air Pollution” Tata McGraw Hill, 1989.

CE 941 AIR AND WATER QUALITY MODELLING

1. System Approach:

Water and air quality management – Role of mathematical models; systems approach – systems and models – kinds of mathematical models – model development and validation effluent and stream standards; ambient air quality standards.

2. Surface Water Quality Modelling:

Historical development of water quality models; rivers and streams water quality modeling – river hydrology and flow – low flow analysis – dispersion and mixing – flow, depth and velocity – estuaries – estuarine transport, net estuarian flow, estuary dispersion coefficient; Lakes and impoundments – Water quality response to inputs; water quality modeling process – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens; Streeter – Phelps models.

3. Air Quality Modelling:

Transport and dispersion of air pollutants – wind velocity, wind speed and turbulence; estimating concentrations from point sources – the Gaussian Equation – determination of dispersion parameters, atmospheric stability; dispersion instrumentation – Atmospheric traces; concentration variation with averaging time; Air pollution modeling and prediction – Plume rise modeling techniques, modeling for non-reactive pollutants, single source – short term impact, multiple sources and area sources, model performance and utilisation, computer models.

4. Groundwater Quality Modelling:

Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement.

5. Computer Models:

Exposure to computer models for surface water quality, groundwater quality and air quality.

References:

1. Steven C.Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997.
2. R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994.
3. Ralph A. Wurbs, Water Management Models – A Guide to Software, Prentice Hall. PTR, New Jersey, 1995.

CE 953 SOLID AND HAZARDOUS WASTE MANAGEMENT

1. **Municipal Solid Waste Management:**
   Legal and Organizational foundation: Definition of solid waste – waste generation 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.

2. **Collection and Transport of Solid Waste:**
   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 user for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, unaerobic methods for materials recovery and treatment – Energy recovery – Incinerators

   Transfer and Transport: Need fir 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 solution, designated waste landfill remediation – Integrated waste management facilities.

3. **Hazardous Waste Management:**
   Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waster regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport.

4. **Hazardous waste treatment and Design:**
   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.

5. **Laboratory Practice:**
   Sampling and characterization of Solid Wastes; TCLP tests and leachate studies.

References:

1. George Techobanoglous et al, “Integrated Solid Waste Management”, McGraw-Hill Publication, 1993.

2. Charles A. Wentz; “”Hazardous Waste Management”, McGraw Hill Publication, 1995.

CE 952 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING

1. Remote sensing

Definition – Components of Remote Sensing - Energy, Sensor, Interacting Body - Active and Passive Remote Sensing – Platforms – Aerial and Space Platforms - Balloons, Helicopters, Aircraft and Satellites- Synoptivity and Repetivity - Electro Magnetic Radiation (EMR) – EMR Spectrum – Visible, Infra Red (IR), Near IR, Middle IR, Thermal IR and Microwave – Black Body Radiation – Planck's Law - Stefan-Boltzman law.

2. Emr Interaction With Atmosphere And Earth Materials

Atmosphere characteristics - Scattering of EMR - Raleigh, Mie, Non –Selective and Raman Scattering – EMR Interaction with water vapour and ozone – Atmosphere Windows – Significance of Atmospheric Windows - EMR interaction with earth surface Materials – Radiance , Irradiance , Incident , Reflected , Absorbed and Transmitted Energy – Reflectance – Specular and Diffuse Reflection Surfaces – Spectral Signature – Spectral Signature curves – EMR interaction with water, soil, and Earth surface

3. Optical And Microwave Remote Sensing

Satellites – Classification – Based on Orbits – Sun Synchronous and Geo Synchronous – Based on Purpose – Earth Resources Satellites, Communication Satellites, Weather Satellites, Spy Satellites, Satellite Sensors, Resolution – Spectral , Spatial Radiometric and Temporal Resolution – Description of Multi Spectral Scanning – Along and Across Track scanners – Description of Sensors in Landsat, SPOT, IRS series – Current Satellites – Radar – Speckle – Back Scattering – Side Looking Airborne Radar - Synthetic Aperture Radar – Radiometer – Geometrical characteristics

4. Geographic Information System

GIS - Components of GIS – Hardware, Software and Organization Context – Data – Spatial and Non Spatial – Maps – Types of Maps – Projection – Types of Projection – Data Input – Digitizer, Scanner - Editing - Raster and Vector data structures - Comparison of Raster and Vector Date structure – Analysis using raster and Vector Data - Retrieval , Reclassification , Overlaying, Buffering – Data Output – Printers and Plotters.

5. Miscellaneous Topics

Visual Interpretation of Satellite Images - Elements of Interpretation - Interpretation Keys Characteristics of Digital Satellite Image - Image enhancement - Filtering - Classification – Integration of GIS and Remote Sensing – Application Remote Sensing and GIS in Environmental Engineering –management and monitoring of land , air , water pollution, conservation of resources and coastal zone management.

Reference:

1. Lilliesand, T.M and Kiefer, R.W., Remote Sensing and Image Interpretation , John Wiley and Sons, 1994.
2. Burrough, P.A and McDonnel, R.A., Principles of Geographic Information Systems, Oxford university press,1998
3. Lintz,J. and Simonet , Remote sensing of Environment, Addison Wesley Pub. Com., 1994
4. Chang , K.T., Introduction to Geographic Information Systems, Tata McGraw – Hill ,2006

CE 944 ECOLOGICAL ENGINEERING

1. Introduction to Ecology and Ecological Engineering

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.

2. Systems Approach in Ecological Engineering:

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

3. Ecological Engineering Processes:

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

4. Ecotechnology for Waste Treatment:

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

5. Case Studies:

Case studies of integrated ecological engineering systems.

References:

1. Mitsch, J.W & Jorgensen, S.E., Ecological Engineering – An Introduction to Ecotechnology, John Wiley & Sons, New York, 1989.

2. White, I.D, Mottershed, D.N and Harrison, S.L., Environmental Systems – An Introductory Text, Chapman Hall, London, 1994.

CE 951 PRINCIPLES OF ENVIRONMENTAL SCIENCE

1. **Introduction:**

   Structure of Environment – interaction between biological and chemical components – Law of Mass Action – Chemical equilibria – Chemical kinetics – Colloidal Chemistry – catalysis and Photocatalysis – Corrosion and its control.

2. **Biological Systems:**

   Plants – Animals – distribution – interaction – biomass – classification – salient features – nutrients and microorganisms – environmental factors.

3. **Microbiology of Environment:**

   Microbiology of water – soil – air. Indicator organisms, - coliforms – MPN index – M.F. technique – Biological indices. Biomonitoring methods – Eutrophication. Biological treatment of wastewater – bacterial reductions. Algae in water supply systems – problems and control. Macrophytes in water bodies –role – control.

4. **Chemistry of Aquatics:**

   Common organic reactions – Enzymes and factors influencing enzymic reactions – Pesticides and syndets – Transformation and degradation of pollutants.

5. **Chemistry of Atmosphere:**

   Structure of the atmosphere – Photochemistry of the atmosphere – ozone layer depletion – Acid rain – Greenhouse gases and global warming.

References:

1. Biswarup Mukherjee, Environmental Biology, Tata McGraw Hill Publishing Company Limited, New Delhi, 1997.

2. Manohaan, S.E., Environmental Science and Technology, Lewis Publication, New York, 1997.

3. Sawyer, C.N., McCarty, P.L. and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edition, McGraw Hill, New Delhi, 1994.
4. De, A.K. Environmental Chemistry, New Age International Limited, New Delhi, 1995.

CE 948 FUNDAMENTALS OF SUSTAINABLE DEVELOPMENT

1. **Principles of Sustainable Development:**

   History and emergence of the concept of Sustainable Development – Definitions – Environmental issues and crisis – Resource degradation – green house gases – desertification – social insecurity – Industrialization – Globalization and Environment.

2. **Indians Judiciary System & Sustainable Development:**

   Judicial System in India – Induction of sustainability concepts through legal systems – concepts – principles – doctrines – case laws.

3. **Sustainable Development and International Contribution:**

   Components of sustainability – Complexity of growth and equity – International Summits – Conventions – Agreements – Transboundary issues – Action plan for implementing sustainable development – Moral obligations and Operational guidelines.

4. **Socio-economic Sustainable Development Systems:**

   Socio-economic policies for sustainable development – Strategies for implementing ecodevelopment programmes – Sustainable development through trade – Economic growth – Carrying Capacity – Public participation.

5. **Agenda for Future Global Sustainable Development:**

   Role of developed countries in the sustainable development of developing countries – Demographic dynamics and sustainability – Integrated approach for resource protection and management.

References:

1. Kirkby, J., O' Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1996.

2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

3. Bowers, J., Sustainability and Environmental Economics – an alternative text, Longman, London, 1997.

CE 950 INSTRUMENTAL MONITORING OF ENVIRONMENT

1. **Basics of Measurement**

Classification of instrumental methods, signals and noise- sources of noise, noise reduction. Sensitivity and detection limit. Errors-types, expression of errors. Precision and accuracy-methods of expressing an accuracy- methods of expressing precision and accuracy. Calibration of instrumental methods- calibration curves, standard addition and internal standard methods – theory

2. **Spectroanalytical Methods**

Electromagnetic radiation- properties, emission and absorption of radiation. Fluorescence and Phosphorescence. Atomic absorption and emission spectrometry- principle and instrumentation. ICP source. Fluorimetry, nephelometry and turbidimety- principle and instrumentation. Ultraviolet-visible spectrophotometry principle and instrumentation. Beer's law.

3. **Chromatographic Methods**

Classification, general theory- column efficiency and resolution, band broadening. Evaluation methods, quantitative determination . Principle and instrumentation of gas chromatography and HPLC. Ion exchange chromatography and size exclusion chromatography. Mass spectrometry**.**

4. **Electro analytical Methods**

Potentiomety- electrochemical cell, reference electrodes, Glass electrode. Measurement of pH . Potentiometric titrations. Ion – selective electrodes. Conductomety- electrolytic conductivity- specific, equivalent and molar conductance. Conductance cells, conductivity meters. Conductometric titrations. Coulometry and polarography

5. **Radio analytical and Other methods**

Particles emitted in radioactive decay. Measurement of radioactivity- Ionization chamber , proportional counter, scintillation counter and Geiger counter. Isotopic dilution analysis and activation analysis.

NDIR for CO analysis, chemiluminescent analyzer for NOx, fluorescent analyzer for. SO_2 , flow injection analysis and CHN analyzer.

References:

1. H.H, Willard, L.L Merit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 7th Ed. CBP Publishers and Distributors, New Delhi 1986
2. D.A.Skoog, D,M, West and T.A Nieman, Principles of Instrumental Analysis, 5th Ed. Thomson Asion (P) Ltd. Singapore, 2004
3. J. Mendham, R.C Denney, J.D Barnes and M.Thomas, Vogel's Textbook of Quantitative Chemical analysis, 6th Ed. Pearson Education Ltd New Delhi 2002.

CE 945 – ENVIRONMENTAL BIOTECHNOLOGY

1. **Principles and concepts:**
   Principles and concepts of environmental biotechnology – usefulness to mankind.

2. **Microbial Systems for Detoxification of Environmental Pollutants.**
   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 extracellular polymers.

3. **Microbial Technology for Waste Management:**
   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 – odour management – technologies of commercial importance advances in biogas technology – case study.

4. **Recombinant DNA Technology:**
   Concept of rDNA technology – plasmid – cloning of DNA – mutation – construction of microbial strains.

5. **Regulatory and Ethical issues:**
   Environmental effects and ethics of microbial technology – safety of genetically engineered organisms.

References:

1. Wainwright, M, An Introduction to Environmental Biotechnology, 1999.
2. Martin, A.M., Biological Degradation of Wastes, Elsevier Appl. Science, New York, 1991.
3. Sayler, Gray S. Robert Fox and James W. Blackburn Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.
4. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, Lutgarde Raskin, Insitu Bioremediation (2nd Edition) Nayes Publication, U.S.A, 1991.
5. Old R.W., and Primrose, S.B., Principles of Gene Manipulation (3rd Edition) Blackwell Science Publication, Cambridge, 1985.

CE 943 CLEANER PRODUCTION

1. **Introduction:**
   Sustainable Development – Indicators of Sustainability – Sustainability Strategies Barriers to Sustainability – Industrial activity and Environment – Industrialisation and sustainable development – Industrial Ecology – Cleaner Production (CP) in Achieving Sustainability – Prevention versus Control of Industrial Pollution – Environmental Polices and Legislations – Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches.

2. **Principles Cleaner Production:**

   Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Government and Institutions – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.

3. **Cleaner Production Project Development and Implementation:**

   Overview of CP Assessment Steps and Skills, Preparing for the Site, Visit, Site, Visit, Information Gathering, and Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement.

4. **Life Cycle Assessment and Environmental Management Systems:**

   Elements of LCA – Life Cycle Costing – Eco Labelling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit.

5. **Case Studies:**

   Industrial applications of CP, LCA, EMS and Environmental Audits.

References:

1. Paul L Bishop (2000) ‘Pollution Prevention : Fundamentals and Practice’, McGraw Hill International.

2. World Bank Group (1998) ‘Pollution Prevention and Abatement Handbook – Towards Cleaner Production’, World Bank and UNEP, Washington D.C.

3. Prasad Modak, C.Visvanathan and Mandar Parasnis (1995) ‘Cleaner Production Audit’, Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok.

CE 946 ENVIRONMENTAL GEOTECHNOLOGY

OBJECTIVE

The students acquires the knowledge on the geotechnical engineering problems associated with soil contamination, safe disposal of waste and remediate the contaminated soils by different techniques thereby protecting environment.

1. **Soil- Pollutant Interaction:**
   Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physico-chemical behavior and modelling -failures of foundations due to pollutants

2. **Characterization, Stabilization and Disposal**
   Safe disposal of waste – site selection for land fills – characterization of land fill sites – waste characterization –stability of land fills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization -solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification — organic and inorganic stabilization

3. **Transport of Contaminants:**
   Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.

4. **Detection and Testing Methods**

   Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes

5. **Remediation of Contaminated Soils:**
   Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.

R**eferences**:

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993.
3. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.
4. Lagrega, M.d., Bukingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.