Master of Technology

SYLLABUS

CREDIT BASED CURRICULUM

(2013 - 2015)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015, INDIA.

M. Tech. (ENVIRONMENTAL ENGINEERING)

The total credits required for completing the M.Tech. Programme in Environmental Engineering is 66.

SEMESTER – I

Code	Course of Study	L	T	P	C
MA601	Numerical Methods and Applied Statistics	3	0	0	3
CE701	Environmental Chemistry and Microbiology	3	0	0	3
CE703	Physico-chemical Process for Water and Wastewater Treatment	3	1	0	4
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
CE709	Environmental Quality Measurements Laboratory	0	0	3	2
		18	**1**	**3**	**21**

SEMESTER – II

Code	Course of Study	L	T	P	C
CE702	Biological Process Design for Wastewater Treatment	3	1	0	4
CE704	Transport of Water and Wastewater	3	0	0	3
CE706	Air Quality Management	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
CE710	Environmental Microbiology and Engineering Laboratory	1	0	3	2
		19	**1**	**3**	**21**

SUMMER TERM

Code	Course of Study	L	T	P	C
	Practical Training (4 Weeks)	-	-	-	-

SEMESTER III

Code	Course of Study	L	T	P	C
CE747	Project Work	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE748	Project Work	0	0	24	12

ELECTIVES

Sl. No.	Code	Course of Study	L	T	P	C
1.	CE711	Solid and Hazardous Waste Management	3	0	0	3
2.	CE712	Industrial Wastewater Management	3	0	0	3
3.	CE713	Environmental Impact Assessment	3	0	0	3
4.	CE714	Water and Air Quality Models	3	0	0	3
5.	CE715	Contaminant Transport Modeling	3	0	0	3
6.	CE716	Environmental Systems Analysis	3	0	0	3
7.	CE717	Design of Air Pollution Control Systems	3	0	0	3
8.	CE718	Indoor Air Quality	3	0	0	3
9.	CE719	Ecological and Ecosystems Engineering	3	0	0	3
10.	CE720	Process chemistry for water and wastewater treatment	3	0	0	3
11.	CE721	Membrane Technology for Water and Wastewater Treatment	3	0	0	3
12.	CE722	Biodegradation and Bioremediation Techniques	3	0	0	3
13.	CE723	Environmental Policies and Legislations	3	0	0	3
14.	CE724	Cleaner Production and Environmental Sustainable Management	3	0	0	3
15.	CE725	Environmental Health and Eco-Toxicology	3	0	0	3
16.	CE726	Analytical Methods for Environmental Monitoring	3	0	0	3
17.	CE727	Environmental Biotechnology	3	0	0	3
18.	CE728	Environmental Geotechnology	3	0	0	3
19.	CE729	River Engineering	3	0	0	3

20.	CE730	Surface and Ground water modeling	3	0	0	3
21.	CE731	Water Resources Systems Management	3	0	0	3
22.	CE732	Environmental Engineering Structures	3	0	0	3
23.	CE733	Remote Sensing and GIS for Environmental Applications	3	0	0	3
24.	EE778	Analysis and Design of Artificial Neural Networks	3	0	0	3
25.		Any other elective				

SEMESTER I

MA701 NUMERICAL METHODS AND APPLIED STATISTICS

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes' theorem

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

References

1. *Bowker and Liberman, Engineering Statistics, Prentice-Hall, 1972.*
2. *Venkatraman, M.K., Numerical Methods in Science and Engineering*, National Publisher Company.

CE701 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

Colloids – Redox potentials – partition co-efficient – Beer – Lambert's Law – Limitations – UV visible spectroscopy – basic principles – application – Atomic spectroscopy – Principles and applications – Principles of green chemistry – Error Analysis of Environmental Data

Transport and transformation of chemicals – DO, BOD and COD – Photobcatalysis – Degradation of food stuffs, detergents, pesticides and hydrocarbons. Soil chemistry – acid –base and ion-exchange

reactions in soil – salt affected soil and its remediation. Classification of microorganisms- prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microoraganisms- Environmental factors influencing miribial growth.
Distribution of microrganisms- Water, Air and Soil, Indicatorborganisms, coliforms-fecal coliforms, E.coli, Streptococcus,Clostridium, Significance in water. Algae in water supplies- problems and control. MPN and MFT.
Ecotoxicology- toxicants and toxicity, factors influencing toxicity, effects- acute, chronic, concentration,bioaccumulation, biomagnification, bioassay, biomonitoring.

References

1. *C.N. Sawyer, P.L. McCarty, and G.F Parkin, Chemistry for Environmental Engineering, Tata McGraw-Hill, New Delhi, 2003.*
2. *G. W. Vanloon and S. J. Duffy Environmental chemistry – a global perspective, Oxford University press, Newyork., 2000.*
3. *Tortora. G.J, B.R. Furke, and C.L.Case, Microbiology- An introduction (4th Ed.), Benjammin/Cummings publ.Co.,Inc., California,1992.*
4. *Pelczar, M.J., Chan E.C.S. and Krieg, N.R. Microbiology, Tata McGraw Hill, New Delhi, 1993.*

CE703 PHYSICO CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT

Water Quality-Physical, chemical and biological parameters of water- Water Quality requirement-Potable water standards-Wastewater Effluent standards-Water quality indices.
Water purification systems in natural systems-Physical processes-chemical processes and biological processes-Primary, Secondary and tertiary treatment-Unit operations-unit processes.
Mixing, clarification – sedimentation; Types; Aeration and gas transfer – Coagulation and flocculation, coagulation processes-stability of colloids- destabilization of colloids- destabilization in water and wastewater treatment-transport of colloidal particles, Clariflocculation.
Filtration processes- slow sand filtration- rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration.
Adsorption, adsorption equilibria- adsorption isotherms, Disinfection – chlorine dioxide; chloramines; ozonation; UV radiation.
Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis.

References

1. *Weber, W.J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.*
2. *Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.*
3. *Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.*

CE709 ENVIRONMENTAL QUALITY MEASUREMENT LABORATORY

Physical and chemical characteristics of water – pH, Electrical conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates. Analysis of solids content of water: Total solids, Suspendd

solids, volatile solids, non volatile solids, Residual chlorine analysis, Optimum coagulant dose, Break point Chlorination.
Test on dissolved oxygen, BOD and COD.
Ambient air quality Analysis: Determination of SPM, CO, NO_X and SO_X.
Soil Analysis: pH, Conductivity, Cation exchange capacity, Sodium Adsorption ratio

SEMESTER II

CE702 BIOLOGICAL PROCESS DESIGN FOR WASTEWATER TREATMENT

Constituents of wastewaters-Sources-Significant parameter-Fundamentals of Process Kinetics, Zero order, First order, Second order Reactions, Enzyme reactions –Bio reactors- Types- Classification-Design principles.
Design of wastewater treatment systems-Primary, secondary and tertiary treatments- Evaluation of Biokinetic Parameters -Activated Sludge and its process- Modifications, Biological Nitrification and denitrification.
Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors
Waste stabilization ponds and Lagoons: Aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated Lagoons
Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors- Sludge Digestion, Sludge disposal.

References

1. *Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.*
2. *Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.*
3. *Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.*

CE704 TRANSPORT OF WATER AND WASTEWATER

Water storage – Impounding reservoirs – Intakes – pressure conduits – pumps – Economic design of pumps and pumping mains – Pipes – Pipe appurtenances – Water hammer.
Rapson methods, Distribution network analysis- methods of control and prevention of corrosion.
Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers – Partial flow – Sewer designs – Sewer layouts – Storm drainage.
Storm runoff estimation – Hydraulics of flow in storm water drains – hydraulics of flow in storm water drains-storm water drain materials and section-design of storm water drains.
Maintenance of sanitary sewerage and storm drainage – equipments – corrosion in sewers – prevention and control – Waste water pumping networks, Application of software in design of water supply networks.

References

1. *Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.*
2. *Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.*

CE706 AIR QUALITY MANAGEMENT

Air pollutants – Sources and classification of pollutants and their effect on human health vegetation and property- Effects - Reactions of pollutants and their effects-Smoke, smog and ozone layer disturbance - Greenhouse effect – Ambient and stack sampling.

Atmospheric diffusion of pollutants - Transport, transformation and deposition of air contaminants - Air sampling & pollution measurement methods - Ambient air quality and emission standards - Air pollution indices - Air Act

Control principles – Removal of gaseous pollutants by adsorption, absorption, reaction and other methods.

Particulate emission control- settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation.

Biological air pollution control technologies - bioscrubers, biofilters, and Indoor air quality.

References

1. *Wark Kenneth and Warner C.F, Air pollution its origin and control. Harper and Row Publishers, New York, 1981.*
2. *Rao C.S., Environmental pollution control Engineering, New age international Ltd, New Delhi, 1995.*
3. *Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.*

CE710 ENVIRONMENTAL MICROBIOLOGY AND ENGINEERING LABORATORY

Microscopic Examination of Microorganisms: Preparation of bacterial smear - staining - Hanging drop technique - plate count test, MPN tests and MFT Tests. Determination of MLSS and MLVSS in ASP - Coagulation and flocculation of water – Optimization of dose / pH / time of flocculation. Color removal from wastewater by adsorption - Estimation of suspended particulate matter / SPM, NO_x, SO_x.

ELECTIVES

CE711 SOLID AND HAZARDOUS WASTE MANAGEMENT

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management

Waste generation rates – Composition- Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.

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 - labeling and handling of hazardous wastes.

Waste processing – processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies-energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes.

Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation

Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.

Elements of Integrated waste management.

References

1. *George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993*

2. *CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.*

CE712 INDUSTRIAL WASTEWATER MANAGEMENT

Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – generation rates – characterization – Toxicity and Bioassay tests.
Prevention Vs Control of Industrial Pollution– Source reduction techniques – Waste Audit- Evaluation of pollution prevention options.
Waste minimization - Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies - Individual and Common Effluent Treatment Plants – Zero effluent discharge systems - Wastewater reuse – Disposal of effluent on land.
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – Metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – Fertilizers – Thermal Power Plants and Industrial Estates, Waste Audit.

References

1. *Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 1999.*
2. *Arceivala, S.J., Wastewater Treatment for Pollution Control, McGraw-Hill, 1998.*
3. *Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001*.

CE713 ENVIRONMENTAL IMPACT ASSESSMENT

Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Base line Studies- Mitigation – Matrices – Check list.
Rapid and Comprehensive EIA – Legislative and Environmental clearance procedures in India – Prediction tools for EIA.
Assessment of impacts – Air – Water – Soil – Noise – Biological.
Socio cultural environment – Public participation – resettlement and rehabilitation.
Documentation of EIA – Environmental Management plan – Post project monitoring – Environmental Audit – Life cycle assessment – EMS - Case studies in EIA.

References

1. *Canter R.L., Environmental Impact Assessment, Mc Graw Hill International Edition, 1997.*
2. *John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.*

CE714 WATER AND AIR QUALITY MODELS

Modeling approaches to water quality - classification – Mathematical Models for water quality- Conservation of mass- mass balance- steady state system- time variable response system
Mass transport mechanisms - Advective and diffusive mass transport - DO and BOD models for Streams – Point source and multiple point sources Streeter Phelps model - oxygen 'sag' curve - deoxygenation and reaeration coefficients – anaerobic condition-Benthal oxygen demand

Models for Estuary-Estuary transport -Estuary Streeter Phelps -dispersion coefficient-Models for lakes – eutrophication-thermal stratification - physical chemical and biological processes - water quality distribution – temperature models.
Models for microorganisms decay- bacterial growth- microbial kinetics- batch reactor- CSTR reactor
Air quality models - Micrometeorological processes – lapse rate - wind rose – dispersion – stability classes - Gaussian dispersion model - Regional air quality models- Line source models- area source models- An Indoor air quality model

References

1. *Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, Mc Graw Hill International Editions, 1998.*
2. *Pevy, Rowe, and Techobanoglous, Environmental Engineering, Mc Graw Hill Publishing company, Newyork.*
3. *Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice- Hall of India Pvt. Ltd., Newdelhi.*
4. *Bibbero. R.J, and I.G.Young, Systems approach to Air pollution control, John wiley & Sons, Newyork, 1974.*
5. *Chapra, Steven C., Surface water quality modeling, McGraw Hill International Edition, 1997.*

CE715 CONTAMINANT TRANSPORT MODELING

Transport phenomenon – advection - diffusion – dispersion — adsorption - conservative and non-conservative pollutants- Extrinsic and Intrinsic properties- laws of conservation- Reynolds Transport Theorem.
Governing Equations for flow and transport in surface and subsurface waters - chemical and biological process models - simplified models for lakes, streams, and estuaries.
Model complexity - model resolution - coupled and uncoupled models - linear and nonlinear models - Solution techniques – Model input parameters- Initial and boundary conditions -calibration – sensitivity analysis - application and evaluation of environmental control – bioremediation.
Numerical models: FDM- explicit vs. implicit methods - numerical errors - High resolution techniques - Finite volume techniques
Stream quality modeling using QUAL2K - Groundwater transport modeling using VISUAL MODFLOW

References

1. Martin, L.J. and McCucheon, S.C, *Hydrodynamics of transport for water quality modeling*, Lewis Publishers, Boca Raton, 1999.
2. Freeze, R.A. and Cherry. J.A. *Groundwater*, Prentice Hall, 1979.
3. Zheng, C. and Bennett, G. D., Applied contaminant Transport Modeling, A John wiley & sons, inc, publication, Newyork, 2002.
4. Sun, N. Z., Mathematical modeling of groundwater Pollution, Springer –Verlac Newyork Inc., and Geological publishing house, 1996.

CE716 ENVIRONMENTAL SYSTEMS ANALYSIS

Systems Engineering – Analysis - Design – synthesis - applications to environmental engineering Systems.
Role of optimization models - Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models.
Formulation of objective functions and constraints for environmental engineering planning and design.

Probabilistic models - fuzzy models - Simulation models.
Modern tools - Expert systems - Neural networks - Genetic Algorithm - Case studies.

References

1. *Rich L.G., Environmental Systems Engineering, McGraw Hill, 1973.*
2. *Thoman R.V., Systems Analysis & water Quality control, McGraw Hill, 1978.*

CE717 DESIGN OF AIR POLLUTION CONTROL SYSTEMS

Industrial sources of air pollution- Emission factors-regulations- control strategies-policies.
Particulate Pollutant Control: Settling chambers - laminar and turbulent flow- Filtration – interception- Impaction- Convective diffusion- Collection of particles by cylindrical fibres and granular beds- Electrostatic precipitation - Cyclones - Wet collectors.
Gaseous Pollutant Control: Gas absorption in tray and packed towers- Absorption with/without chemical reaction- Removal of SO_2 - Adsorption in fixed beds- Breakthrough.
Removal of HCs/ VOCs- NO_X removal - Wet scrubbers.
Integrated air pollution control systems.

References

1. Lawrence K.Wang, Norman C Perelra, Yung-Tse Hung, *Air pollution control Engineering*, Tokyo.
2. Noel de Nevers, *Air pollution control Engineering*, McGraw Hill, New York.

CE718 INDOOR AIR QUALITY

Indoor activities of inhabitants - Levels of pollutants in indoor and outdoor air- Design and operation of buildings for improvements of public health- IAQ policy issues- sustainability.
Air pollutants in indoor environments- private residences- offices- schools-public buildings- ventilation.
Control of several pollutant classes- radon- toxic organic gases- combustion byproducts- microorganisms such as molds and infectious bacteria.
Concepts and tools- exposure- material balance models- statistical models.
Indoor air pollution from outdoor sources- particulate matter and ozone- Combustion byproducts- Radon and its decay products- Volatile organic compounds- odors and sick-building syndrome- Humidity- Bio aerosols- infectious disease transmission- Special indoor environments- A/C units in indoor- Measurement methods- Control technologies- Control strategies.

References

1. *Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000.*
2. *Nazaroff W.W. and L. Alvarez-Cohen, Environmental Engineering Science, Wiley sons, Newyork, 2001*.

CE719 ECOLOGICAL AND ECO SYSTEMS ENGINEERING

Development and evolution of ecosystems – Principles and concepts – Energy flow and material cycling – productivity – Classification of ecotechnology – ecological engineering.
Classification of systems – Structural and functional interactions of environmental systems – Mechanisms of steady-state maintenance in open and closed systems.
Modeling and ecotechnology – Classification of ecological models – Applications- Ecological economics- Self-organizing design and processes – Multi seeded microcosms.

Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.
Ecosanitation – soil infiltration systems – Wetlands and ponds – Source separation systems – Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes – marine systems- Case studies.

References

1. *Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice, Lewis Publishers, New York, 2003.*
2. *Etnier, C. and Guterstam, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers, New York, 1997.*

CE 720 PROCESS CHEMISTRY FOR WATER AND WASTEWATER TREATMENT

Environmental Chemistry Basic concepts from general chemistry: chemical equations, types of chemical reactions, calculations from chemical equations, solutions, activity and activity coefficients, chemical equilibria, chemical thermodynamics, factors affecting chemical equilibrium. Gas laws.
Acid Base Equilibria: fundamentals, equilibrium diagrams, alkalinity and acidity, the carbonic acid system, buffering in water systems, measuring alkalinity.
Solubility Equilibria: Solubility equlilibria for slightly soluble salts, effect of other solutes on salt solubility, removal of heavy metals from complex water and wastewater systems.
Oxidation reduction Equlilibria: oxidation reduction processes galvanic cell and chemical thermodynamics, stability diagrams measuring redox potentials.
Water Stabilization: Electrochemical aspects of corrosion, water stabilization, Langelier saturation index, Caldwell Lawrence diagrams, Water softening and neutralization: chemical precipitation, ion exchange Application of Redox Chemistry:

References

1. Benfield, L.D.; Weand, B.L.; Judkins, J.F. (1982) *Process chemistry for water and wastewater*. Prentice Hall Inc Englewood Cliffs New Jersey.
2. Weber Jr., W.J. (1972) *Physico-chemical Process for Water Quality Control*. Wiley Inc. Newyork.

CE721 MEMBRANE TECHNOLOGY FOR WATER AND WASTEWATER TREATMENT

Principles of Membrane processes- Types and Classification- Theory of Membrane separation- Types and choice of membranes– Liquid Membranes- Characterization of membranes-Recent development in membranes-Modules and washing process.
Electrodialysis- principles- Electro dialysis stack and its various components- ion exchange capacity- Electrical resistance of ion exchange membrane-Donnon dialysis- Reverse osmosis- theory and principle- membrane materials- design considerations.
Filtration- theory- Nanofiltration- Ultrafiltration- Microfiltration- Membrane Module/Element designs- Design of Membrane systems- Membrane bioreactors- Biotreatment Fundamentals, Biomass Separation MBR Principles- MBR Design Principles – Submerged anaerobic membrane bioreactors.
Fouling- Pretreatment methods and strategies – Langlier and Silt indexes- cleaning methods- Foulants analysis- disposal of RO concentrate- rejects in membranes.
Synthetic Membranes- preparation methods- composite membranes- preparation methods and applications- immersion precipitation preparation techniques- phase inversion membranes- Introduction to module and process design -zero Liquid effluent discharge Plants.

References

1. R.D. Noble and S.A. Stern, Membrane Separations Technology: Principles and Applications, Elservier, 1995.
2. E.D. Schroeder, Water & Wastewater Treatment, McGraw Hill, 1977.
3. J.G. Crespo and K.W. Boddekes, Membrane Processes in Separation and Purification, Kluwer Academic Publications, 1994.
4. R. Rautanbach and R.Albrecht, Membrane Process, John Wiley & Sons, 1989.

CE722 BIODEGRADATION AND BIOREMEDIATION TECHNIQUES

Bioremediation and biodegradation- Historical perspectives of biodegradation and bioremediation - contaminant bioavailability- microbial catabolism of organic pollutant - catabolic enzymes- properties- designing of microorganisms- biodegradation measurement potential-impediments to microbial biodegradation.

Biodegradation Detoxication Reactions – Principles of biodegradation- Biodegradation kinetics- Effect of pollutant chemical structure on biodegradation- Fate and transport of contaminants in soils and water bodies- Requirements of biodegradation- nutritional factors- Chemical structure- environmental factors- biological factors- Bioavailability and aging

Bioremediation monitoring and assessment methods- conventional plating and microbial enumeration- biochemical and physiological methods- BIOLOG- soil enzyme assay- immunochemical methods- phospholipids fatty acid analysis- molecular biology based methods- bacterial biosensors- molecular techniques- Toxicological risk assessments.

Biodegradation of organic compounds- anaerobic biodegradation of benzene and ethyl benzene- polyaromatic transformation and degradation- co-metabolic process for polychlorinated biphenyl degradation- aerobic hexachlorocyclohexane biodegradation- co posting of contaminated soil.

Improved bioremediation by engineering microbes- Bioadsorbents- metal precipitation- enzymatic transformation of metals- strains for enhanced biodegradation-improved biodegradation by protein

References

1. A. Singh and O.P. Ward Biodegradation and bioremediation, Springer-Verlag Berlin Heidelberg New York, 2004.
2. K.H. Baker and D.S. Herson, Bioremediation, McGraw-Hill, Inc., New York, 1994.
3. M. Alexander, Biodegradation and Bioremediation, Academic Press, 1999.

CE723 ENVIRONMENTAL POLICIES AND LEGISLATIONS

Common environmental laws-Role of judiciary in environmental protection- Criminal law, Common law-Criminal procedure Code-Indian Penal Code-Fundamental Rights and Fundamental Duties-International and national efforts at environmental protection-Green funding and taxes-National Environmental policies-Framework for environmental impact assessment.

Pollution control acts for water and air pollution-Water Prevention and Control of Pollution) Act, 1974-Water (Prevention and Control of Pollution) Cess Act, 1977 - Air (Prevention & Control of Pollution) Act, 1981.

Other environmental protection acts-Environmental (Protection) Act, 1986; Forest Conservation Act, 1980 - National Forest Policy 1988 - Wild Life (Protection) Act, 1972, Public Insurance & Liabilities Act, 1991- Biomedical wastes (management and handling)- Noise pollution, Eco - labeling, and E.I A. Coastal zone Notification (1991).

International laws- Stockholm Conference- The Rio Earth Summit, 1992 - Rio+5 and the Rio+10- Montreal Protocol, Kyoto Summit, 1997 - Nairobi Declaration, World Summit on sustainable development, 2002- Role of UN authorities in protection of Global Environment - Global environmental issues and International laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste. Sustainable developments and environmental movements-Sustainable development principles, indicators of sustainability - sustainable development models- national and international sustainable development scenarios

References

1. S. Divan and A. Roseneranz, Environmental law and policy in India, Oxford University Press, New Delhi, 2001.
2. R. K. Sapru, Environmental Management in India Vol. I & II): Ashish Publishing House, 2004.
3. Gupta, K.R., Environmental Legislation of India, Atlantic Publishers, 2006.

CE724 CLEANER PRODUCTION AND ENVIRONMENTAL SUSTAINABLE MANAGEMENT

Concepts of Sustainable Development – Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability – Resource degradation - Industrialization and Sustainable development – Industrial Ecology – Socio economic policies for sustainable development - Clean development mechanism, cleaner Production (CP) in Achieving Sustainability.
Principles and concepts of Cleaner Production- Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.
Overview of CP Assessment Steps and Skills- Preparing for the Site visits-Information Gathering - 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- green house gases and carbon credit- carbon sequestration- Sustainable development through trade - carbon trading.
Elements of Life Cycle Assessment (LCA) – Life Cycle Costing – Eco Labelling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management.
Industrial applications of CP, LCA, EMS and Environmental Audits- green energy and green process management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.

References

1. J. Kirkby, P. O'Keefe and Timberlake, Sustainable Development, Earthscan Publication,London, 1996.
2. P.L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2000.
3. P. Modak, C. Visvanathan and M. Parasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 1995.

CE725 ENVIRONMENTAL HEALTH AND ECO-TOXICOLOGY

Need for developing Environment- Health and Safety systems in work places- Extent of industrial pollution- Public exposure from industrial sources- Major chemical contaminants at workplace- Hazards

by industry and its environmental effects- Status and relationship of Acts- Regulations and Codes of Practice.
The relationship of occupational hygiene/ safety and disease-Occupational Safety and Health Administration- Principles and methods of occupational health- Occupation Health and Safety Policy- OH & SMS Documentation- Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals- Health hazard in agriculture - Pesticides and environment- Pesticides and human health- Right to know Laws.
Overview, planning, hazard identification and risk assessment- Biological, chemical, physical and psychological health hazard- Health risk assessment and management in Tanneries, Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.
Toxic substances in the environment- their sources and entry roots- Routes of toxicants to human body – entry through inhalation, skill absorption, indigestion and injection- Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water-Transport through food chain - bio-transformation and bio-magnification
Accident Causation - Need for Accident Investigation, Accident investigation plan, Methods of Acquiring Accident Facts, Response to toxic exposures – Dose response, Frequency response and cumulative response- Lethal and sub-lethal doses; Dose- Response relationships between chemical and biological reactions. Detoxification in human body - detoxification mechanisms, organs of detoxification. Education and Training in health Hygiene.

References

1. H. Koren, Handbook of Environmental Health and Safety – principle and practices, Lewis Publishers, 1991.
2. I. C. Shaw and J. Chadwick, Principles of Environmental Toxicology, Taylor & Francis ltd, 1998.

CE726 ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING

Classification of instrumental methods- Performance characteristics of instruments (static and dynamic)- errors and uncertainties in performance parameters- noise reduction- Sensitivity and detection limit- Errors-types- expression of errors- Precision and accuracy- Calibration of instrumental methods.
Spectophotometry - Electromagnetic radiation -Atomic absorption and emission spectrometry - Ultraviolet-visible spectrophotometry principle and instrumentation- Atomic adsorption spectroscopy principle and instrumentation- Flame photometer- Fluorimetry- nephelometry and turbidimety- principles
Chromatography- principle and classification- column efficiency and resolution- quantitative determination- Column Chromatography- Thin Layer Chromatography- Principle and application of Ion-chromatography- Application Gas Chromatography(GC)- Principle and application of high precision liquid chromatography (HPLC)- Ion Chromatography- Mass Spectroscopy-GC-MS.
Electro chemical methods- electrochemical cell- reference electrodes- Cyclic votametry-Polarograph-Oscilloscopi Polarography- Ion Selective Electrodes- Conductomety- electrolytic conductivity specific-equivalent and molar conductance- working principles of pH, EC, TDS meters.
Material characterization techniques- SEM, TEM, XRD, FTIR, thermal analysis- working principles and applications.

References

1. D.A. Skoog, D.M. West and T.A. Nieman, Principles of Instrumental Analysis,5th Ed. Thomson Asion (P) Ltd. Singapore, 2004
2. 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

CE727 ENVIRONMENTAL BIOTECHNOLOGY

Environmental Biotechnology -Principles and concepts - usefulness to mankind.
Degradation of high concentrated toxic pollutants- halogenated, non halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.
Biotechnological remedies for environmental pollution - decontamination of groundwater – bioremediation - Production of proteins – biofertilizers - Physical, chemical and microbiological factors of composting – health risk – pathogens – odor management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology– extra cellular polymers - Biogas technology.
Concept of rDNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains - radioactive probes - protoplast fusion technology – applications.
Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment-Risk assessment.

References

1. *Chaudhury, G.R., Biological degradation and Bioremediation of toxic chemicals, Dioscorides Press, Oregon, 1994.*
2. *Martin.A.M, Biological degradation of wastes, Elsevier Applied Science, London, 1991.*
3. *Blaine Metting.F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993*

CE 728 ENVIRONMENTAL GEOTECHNOLOGY

Soil as a multiphase system; Soil – environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.
Soil mineralogy; significance of mineralogy in determining soil behavior; Mineralogical characterization.
Mechanisms of soil - water interaction: Diffused double layer models; force of attraction and repulsion; soil – water – contaminant interaction; theories of ion exchange; influence of organic and inorganic chemical interaction.
Introduction to unsaturated soil mechanics; water retention property and soil water characteristic curve; flow of water in unsaturated soil.
Concept of waste containment facilities; desirable properties; contaminant transport and retention; contaminated site remediation.
Introduction to advanced soil characterization techniques; Volumetric water content; Gas permeation in soil; electrical and thermal properties; pore size distribution; contaminant analysis.

References

1. *Mitchell, J.K and Soga, K Fundamentals of soil behavior, John Wiley and sons Inc., 2005.*
2. *Fang, H-Y, Introduction to Environmental Geotechnology, CRC Press, 1997.*
3. *Daniel, D.E, Geotechnical practice for waste disposal, Chapman and Hall, 1993.*
4. *Rowe, R.K, Quigley, R.M and Booker, Clay Barrier systems for Waste disposal facilities, J.R., E & FN Spon, 1995.*
5. *Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook , Kluwer Academic publishers, 2001.*
6. *Reddi, L.N. and Inyang H.F, Geoenvironmental Engineering – Principles and Applications, Marcel Dekker Inc., 2000.*
7. *Sharma, H.D. and Lewis, S.P, Waste Containment systems, Waste stabilization and Landfills: Design and evaluation, John Wiley & sons Inc., 1994.*

CE729 RIVER ENGINEERING

Classification of free surface flow, velocity and pressure distribution, Uniform flow.
Dynamics equation for gradually variedd flow- Classification of flow profiles, Computational methods, Prismatic channels.
Energy and Momentum principles in open channel flow, Rapidly Varied Flow, Hydraulic jump- Analysis.
River Hydrology & Distribution of water quality Rivers, Estuaries, Physical and Hydrological Characteristics of Lakes.
Sediment Transport, Properties, Initiation of Sediment Transport, Bed load, Bed forms, Bed roughness, Suspended load, Total load, Meandering of Rivers, Scouring at different structures.

References

1. *Garde, R.J. Rangaraju, K.G."Mechanics of Sediment Transportation and Alluvial Stream problems", 1978.*
2. *Santhosh Kumar Garg., "Irrigation Engineering & Hydraulic structures", Khanna Publishers, 2006.*
3. *Subramanya., "Flow in Open Channels", Tata McGraw Hill, 2001.*

CE730 SURFACE AND GROUNDWATER MODELLING

Land Processes – Subsurface and channel processes – Precipitation – Rain gauge network – Abstractions, Infiltration, Evaporation, Transpiration, Process and Models.
Unit Hydrograph and S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed model and Conceptual model.
Occurrence and movement of ground water- Properties of aquifer, Ground water flow equation, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.
Pumping tests, Analysis of unconfined and non leaky and leaky confined aquifer and water table aquifer, locating hydrogeologic boundaries, well design criteria.
Natural and artificial recharge of groundwater - salt water intrusion, application of finite difference in ground water.

References

1. *Ven Te Chow,"Applied Hydrology", Mc GrawHill Science Publishers, 1988*
2. *Singh ,Vijay ., "Elementary Hydrology", Prentice Hall ,1994*
3. *Raghunath. "Ground water", Mc Graw Hill, 2007*
4. *Bear , J., Hydraulics of Ground water, Mc Graw Hill, 2007*

CE731 WATER RESOURCES SYSTEMS MANAGEMENT

Reservoir planning, Management, Multireservoir systems, Real time operation, River basin planning, water logging, soil salinity, salinity control.
Design of Dams, Non gravity Dams, Weirs and Barrages, Conjunctive use of Irrigation Water, Quality of Irrigation water, Contaminants and their effects on various crops.
Rain water Harvesting and Management- different types and methods of harvesting in urban and agricultural areas.
Drought analysis, NCA classification, Direct and Indirect losses, Drought severity assessment, Drought Monitoring, Drought Management.
Introduction to systems approach, Linear programming, Problem formulation, Solution by simplex method, Application to design and operation of reservoir, Non-Linear Programming, Sensitivity analysis, Monte Carlo Simulation.

References

1. *Dilip Kumar Majumdar, "Irrigation Water Management (Principles and practices)", Prentice Hal of India (P). Ltd., 2004.*
2. *Water Resources Systems, "Vedula & Mujumdar", Mc Graw Hill, 2005.*
3. *Daniel P. Loucks, "Water resources systems Planning and Management (Studies and Reports in hydrology)", 2006.*

CE732 ENVIRONMENTAL ENGINEERING STRUCTURES

Structural design of Concrete- Prestressed Concrete - anchorage for pipes - massive outfalls.
Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory.
Design of water retaining structures- Design of circular, rectangular, spherical and Intze type of tanks- Design of prestressed concrete cylindrical tanks.
Underground reservoirs and swimming pools- Intake towers- Structural design of settling tanks- clarifloculators- aeration tanks - effect of earth pressure and uplift considerations.
Identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

References

1. *Krishna Raju, Prestressed Concrete, Tata McGraw Hill, 1988.*
2. *Sinha N.C., Roy S.K., Reinforced Concrete, S. Chand and Co, 1985.*

CE733 REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS

Fundamentals of geographic information system, geo-data type, Input Sources, Raster and Vector data structures, Comparison of Raster and Vector data structure, Analysis using Raster and Vector data, Projection and transformation, Retrieval, Reclassification, Overlaying, Buffering.
Electro-magneticenergy, spectrum, EMR interaction with atmosphere, Scattering, Atmospheric Windows and its Significance, EMR interaction with Earth Surface Materials, Spectral Signature EMR interaction with water, soil and Earth Surface. Introduction to image processing, Pre-processing and corrections, Visual Interpretation of Satellite Images, Environmental Satellites: GOES, NOAA, AVHRR, CZCR, OCM and MODIS.
Data base creation and quality modeling using GIS, Water supply and sewage network using GIS, Eutrophication in lakes and reservoir, Groundwater vulnerability, DRASTIC model, Remote Sensing application of reservoir and coastal water quality modeling,
Remote Sensing application on soil salinity mapping, soil erosion-land degradation, Impact of agricultural and industrial activity on soil properties, Catchment nutrients transport modeling, Monitor and mapping of atmosphere constituents, aerosol using MODIS satellite.
Modeling of land slides, suitable site for disposal of solid waste using Multi Criterion Analysis, GIS for health and emergency management, Impact analysis.

References

1. Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, Third edition, 2007.
2. Allan Brimicombe., GIS Environmental Modeling and Engineering, Taylor &Francis, 2003.
3. Lai, Poh C., Mak, Ann S.H. (Eds.)GIS for Health and Environment, Springer Publication, 2007.
4. Uzair M.S., GIS Tools for Water, Wastewater, and Storm water Systems, ASCE Press, 2002.
5. George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.