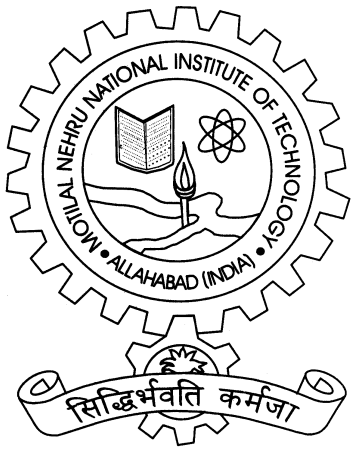
Course Structure & Curriculum

For

M. Tech. in Environmental Engineering

From

Academic Session: 2017-18



Department of Civil Engineering
Motilal Nehru National Institute of Technology Allahabad
Prayagraj -211004 (India)

Course Structure for M. Tech. in Environmental Engineering

Course Name: M.Tech. in Environmental Engineering

Eligibility:

(1) B. Tech. / B.E. or equivalent in First Class in Civil Engineering, Civil Engineering & Planning, Civil Environmental Engineering, Civil Technology, Environment & Pollution Control, Environmental Engineering, Environmental Science & Engineering/Technology

(2) Valid GATE Score card

Scheme of Examination

First Semester

S. No.	Course No.	Subject Name	Credits	L	T	P	Distribution of Marks (100)		
							TA	Mid	End
1	CE - 21121	Physico-Chemical Processes in Water & Wastewater Treatment	**4**	**3**	**1**	**0**	**20**	**20**	**60**
2	CE - 21122	Air Pollution Control	**4**	**3**	**1**	**0**	**20**	**20**	**60**
3	CE -213XX	Elective I	**4**	**3**	**1**	**0**	**20**	**20**	**60**
4	CE -213XX	Elective II	**4**	**3**	**1**	**0**	**20**	**20**	**60**
5	CE -213XX	Elective III	**4**	**3**	**1**	**0**	**20**	**20**	**60**
Total Credits			**20**						

Second Semester

S. No.	Course No.	Subject Name	Credits	L	T	P	Distribution of Marks (100)		
							TA	Mid	End
1	CE - 22121	Principles of Biological Wastewater Treatment	**4**	**3**	**1**	**0**	**20**	**20**	**60**
2	CE - 22221	Advanced Environmental Engineering Laboratory	**4**	**0**	**0**	**6**	**50**	**-**	**50**
3	CE -223XX	Elective IV	**4**	**3**	**1**	**0**	**20**	**20**	**60**
4	CE -223XX	Elective V	**4**	**3**	**1**	**0**	**20**	**20**	**60**
5	CE -223XX	Elective VI	**4**	**3**	**1**	**0**	**20**	**20**	**60**
Total Credits			**20**						

Third Semester

S. No.	Course No.	Subject Name	Credits	Marks
1	CE - 23661	Special Study / Industrial Training / Colloquium/Term Paper	**4**	**100**
2	CE - 23611	Thesis	**16**	**100**
Total Credits			**20**	

Fourth Semester

S. No.	Course No.	Subject Name	Credits	Marks
1	CE - 24612	Thesis I	**20**	**100**
Total Credits			**20**	
Total Credits of all the Semesters			**80**	

Note: The distribution of thesis evaluation marks will be as follows.

1. Supervisor(s) evaluation component : 60%
2. Oral Board evaluation component: 40%

List of Electives:

Electives					
		Odd Semester			**Even Semester**
EI	CE- 21351	Environmental Policies & Legislation	EIV	CE- 22351	Biochemistry & Microbiology
	CE- 21352	Ground Water Hydrology		CE- 22352	Design of Water & Wastewater System
	CE- 21353	Oil Pollution & Marine Waste Disposal		CE- 22308	Finite Elements Methods
	MA- 21301	Mathematical Methods in Environmental Engineering		CE- 22309	Structural Design of Environmental Engineering Systems
EII	CE- 21354	Rural Water Supply & Wastewater Disposal	EV	CE- 22353	Industrial Wastewater Treatment & Reuse
	CE- 21355	Nuclear and Noise Pollution Control		CE- 22354	Air and Water Quality Modeling
	CE- 21356	Environmental Engineering Chemistry & Microbiology		CE- 22355	Chemodynamics
	CE- 21357	Soft Computing Methods in Engineering problem Solving		CE- 22333	Geo-Environmental Engineering
EIII	CE- 21358	Solid & Biomedical Waste Management	EVI	CE- 22356	Hazardous Waste Management
	CE- 21222	Environmental Quality Laboratory		CE- 22357	Groundwater Contamination and Pollution Transport
	CE- 21359	Remote Sensing & GIS		CE- 22358	Environmental Impact Assessment
	CE- 21360	Numerical Computation and Simulation		CE- 22359	Management and Modelling of Environmental Systems

Syllabus of M. Tech. in Environmental Engineering

CE - 21121: Physico-Chemical Processes in Water & Wastewater Treatment

Credit: 4 **3L – 1T – 0P**

Unit 1: Water quality parameters, Water quality criteria and different standards.

Unit 2: Physicochemical processes for water treatments.

Unit 3: Sedimentation, floatation, chemical coagulation.

Unit 4: Flocculation, filtration, disinfection, water softening.

Unit 5: Adsorption, ion- exchange and mass transfer.

Unit 6: Micro, Nano & Ultrafiltration, Reverse Osmosis, Advance oxidation process.

Reference Books:

1. *Metcalf & Eddy, Inc. " Wastewater Engineering: Treatment, Disposal and Reuse ", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
2. *Weber, W.J., "Physico - Chemical Processes for Water Quality Control", John Wiley and Sons, New York, 1977.*
3. *Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill Book Co., International Ed., 1985.*
4. *Fair, G.M., Geyer J.C and Okun, Water and Waste water Engineering" Vol. II, John Wiley Publications New York, 1966.*
5. *Qasim, S.R., "Water works Engineering", Prentice-Hall of India, New Delhi, 2002.*

CE - 21122: Air Pollution Control

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction: Definitions, History of Air Pollution, And Atmosphere-its structure and composition, changes due to man's activities. Major Air pollutants-their sources and effects in quality criteria and ambient air quality standard.
Unit 2: Meteorology: Introduction, Solar radiation, Wind circulation lapse rate, Stability conditions, wind velocity profile, Maximum mixing depth, wind-roses, Atmospheric turbulence, general characteristics of stack plumes, heat island effect, global circulation of pollutants. Dispersion of pollutants-Gaussian and other models, calculation of effective stack height.

Unit 3: Control of Particulates: Particulate distribution, collection efficiency, Settling and Deposition. Particulate collection mechanisms, control equipment.
Unit 4: Control of gasses and vapors: Adsorption and absorption processes, Kinetic reactions, Carbon Monoxide emission control, Incineration or after-burning processes, control of oxides of sulphur and oxides of Nitrogen, General control methods, flue gas control.
Unit 5: Photo- Chemistry of atmosphere: Photo-Chemical reactions, Monatomic oxygen and ozone formation, role of oxides of Nitrogen, Hydrocarbons and oxidants in photochemical smog; Oxidation of SO_2 in polluted atmospheres.
Unit 6: Automobile Pollution: Automobile emissions and their control techniques. Automobile emission standards. Legislation and regulatory trends: Air pollution laws, standards and implementation and compliance.

Reference Books:

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 Delhi, 1995.*
3. *M. N. Rao et al, " Air Pollution ", Tata McGraw Hill, 1989.*
4. *Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill Book Co., International Edn., 1985.*
5. *Paul N. Cheremiseriniff, "Air Pollution Control and Design for Industry", Marcel Dekker, Inc., New York, 1993.*
6. *R.D. Ross, "Air Pollution and Industry", Van Nostrand Reinhold Company, New Delhi, 1972.*
7. *Herbert F., "Industrial Pollution Control Handbook ", McGraw-Hill, New Delhi, 1971.*

CE- 21351: Environmental Policies and Legislation

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction: Role of national, international and UN agencies in dealing with environmental aspects, standards and setting criteria; Historical aspects.
Unit 2: History of legislations in India and provisions of pollution control in CrPC & IPC of country.
Unit 3: Significant legislations in the Indian context; Indian forests Acts 1950 and 1980 and its other amendments.
Unit 4: Environmental Protection Act, 1986 and other Acts related to Water & Air pollution and its other amendments.
Unit 5: ISO 14000, ISO 18000 and ISO 22000 series of standards': Basic features and benefits. Hazardous waste (Management & Handling) Act & other relevant Acts enacted by the Govt. of India and their successive amendments.
Unit 6: Case studies; landmark judgments and Critical evaluation of current environmental risk management policy.

Reference Books:

1. *Constitution of India Eastern Book Company, 12th Edition Lucknow, 1997.*
2. *Pandey, J.N., Constitutional Law of India, 31st Edition, Central Law of Agency, Allahabad, 1977.*
3. *Kesari, U.P.D., Administrative Law, Universal Book Trade Delhi, 1998.*
4. *Tiwari, H.N., Environmental Law, Allahabad LawAgency,1997.*
5. *Rosencrany, A., Divan and Noble M. Environmental Law and Policy in India (Cases, Materials and Statues), Bombay, 1991.*
6. *Environmental Policy. Forest Policy. Bare Acts- Government Gazette Notification.*

CE- 21352: Ground Water Hydrology

Credit: 4 **3L – 1T – 0P**

Unit-1: Introduction. Groundwater in Hydrological cycle, groundwater as a resource, general problems of chemical contamination in groundwater.
Unit-2: Ground water movement and soil heterogeneity. Fluid potential, heterogeneity and anisotropy. Aquifers, aquitards and general geology, Ground water movement: Darcy's Law, Hydraulic conductivity, parameter estimation.
Unit-3: Flow equations. General flow equation. Steady and transient flow equations, unsaturated flow equation, Solution techniques to flow equations.
Unit 4: Well hydraulics. Well hydraulics; Water wells: Methods of construction of shallow and deep wells, well completion and development. Pumping equipment for sanitary protection of wells, Collector wells. Infiltration galleries.
Unit 5: Sea Water Intrusion. Seawater intrusion in coastal aquifers- Basic of problem and examples, solution to the problem.
Unit-6: Ground Water Flow Modelling and Simulation. Modelling and simulation techniques; Softwares- MODFLOW, Visual MODFLOW, Case studies and applications.

Reference Books:

1. *Garg, S. K. "Water Resources Engineering ", Khanna publishers, Delhi, 1973.*
2. *Punamia, B. C. "Water Resources Engineering ", Lakshmi Publications, New Delhi, 1969.*
3. *Subramanya, K., "Engineering Hydrology", 2nd Ed., Tata McGraw-Hill Pub. Co., New Delhi, 1994.*

CE- 21353: Oil Pollution and Marine Waste Disposal

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction: types of oil sources
Unit 2: Significance of oil pollution, Effect on plant and animal life
Unit 3: Prevention of oil pollution, Methods of control, Legal aspects of oil pollution
Unit 4: Sources of marine waste, disposal of marine waste
Unit 5: Physical and Chemical parameters of marine waste disposal
Unit 6: Biological parameters of marine waste disposal, Limitation of indicator organisms, etc.

Reference Books:

1. *International Maritime Organization, "Manual on Oil Pollution: Combating oil spills," IMO Publications, UK, 2005.*
2. *Perason, E. A. and De Fraja Frangipane, E. (Ed.), "Marine Pollution and Marine Waste Disposal ," Proceedings of the 2nd International Congress, San Remo, 17–21 December, 1973, Pergamon Press Ltd. , UK*
3. *Cormack, D., "Response to Marine Oil Pollution: Review and Assessment," Springer Netherlands, 1999.*
4. *Gerlach, S. A., "Marine Pollution: Diagnosis and Therapy," Springer - Verlag, 1981.*

MA- 21301: Mathematical Methods in Environmental Engineering

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction of different Numerical Techniques. Concept of Discrete Continuum, discontinuum, FEM, FDM, FVM, Linear Equations and Eigen-value Problems, Direct and iterative methods for solution of linear system and their error and analysis, Jacobi, Given's and Householder transformations for Eigen value problems, Errors in polynomial interpolations, Newton finite difference method, Lagrange finite difference method, Stirling, Bessel and Everett's interpolating polynomials.

Unit 2: Numerical Differentiation and Integration. Numerical differentiation by interpolating polynomials and error analysis, Numerical integration by Trapezoidal and Simpson's rule, Cubic spline method, Romberg integration.

Unit 3: Numerical Solution of Ordinary Differential Equations. Taylor series method, Modified Euler method, Runge-Kutta methods of order second and fourth, Boundary value problems.

Unit 4: Transportation Models. Construction and solution of these Model, the transportation problem, matrix form of transportation problem, Initial basic feasible solution, Transportation algorithm, Degeneracy and transportation problem, Replacement problem, Assignment problem-Hungarian method.

Unit 5: Statistics. Probability basics, Special distribution: Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Normal joint distributions, Marginal and conditional distributions, Moments, Independence of random variables.

Unit 6: Analysis of variance (ANOVA), one way, two methods, Covariance, Correlation, Regression Problem: Scatter diagram, Simple linear regression, Least squares estimation, multiple regressions**.** T-test, chi-test, f-test, z-test, Analysis of variance (ANOVA) - One-way, Two- way methods, SPSS software, etc.

Reference Books:

1. *Berthouex, P.U., "Statistics for Environmental Engineers ", Lewis Publ., 1994.*
2. *Freund, J.E. and Miller, I.R., "Probability and Statistics for Engineers ", Prentice - Hall of India, 5th Edition, New Delhi, 1994.*
3. *Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics ", Sultan Chan & Sons, New Delhi, 1999.*
4. *Ang, A.H.S. and Tang W.H., "Probability concepts in Engineering Planning and Design - Basic Principles Vol.1 ", John Wiley and Sons, Inc. New Delhi, 1975.*
5. *Taha, H.A., " Operations Research: An Introduction ", Prentice - Hall of India, 6th Edition, New Delhi, 1997.*
6. *Jain, M.K., Iyengar, S.R.K. and Jain, R.K. "Numerical Methods for Scientific and Engineering Computations, 3rd Ed. New Age International (P) Ltd, Publisher, New Delhi.*
7. *Gupta, S. K. "Numerical Methods for Engineers" New Age International (P) Ltd, Publisher, New Delhi.*
8. *Larson, H.J., "Introduction to Probability Theory and Statistical Inference" 3rd Ed., John Willey and Sons, New York, 1982.*

CE- 21354: Rural Water Supply and Wastewater Disposal

Credit: 4 **3L – 1T – 0P**

Unit 1: Development of rural water supply programme: Basic considerations. Planning, Role of various governmental and private agencies, Role of a sanitary engineer.
Unit 2: Installations of various types of Water Supply Systems, Ground Water Pumps. Surface Water. Treatment under rural conditions, Distribution and use.
Unit 3: Management of Rural Water Supply Systems: Importance of management. Personal and training, Administration and finance, Operation and maintenance.
Unit 4: Plumbing systems for homes and farms.
Unit 5: Installation of various types of wastewater systems: Privies, Cesspools, Septic tanks, Disposal of effluents from septic tanks, etc.
Unit 6: Garbage and Refuse Disposal Systems: Various treatment technologies and their suitability to rural and small communities.

Reference Books:

1. *"Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.*
2. *"Manual on Sewerage and Sewage Development ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.*
3. *Holket, "Small Community Water Supply", John Willey & Sons, Co. Ltd.*
4. *Wagner and Lamox, "Excreta Disposal for Rural areas and Small Communities", World Health Organisation, 1958.*
5. *Metcalf & Eddy, Inc. "Wastewater Engineering -Treatment ", Disposal and Reuse, Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*

CE- 21355: Nuclear and Noise Pollution Control

Credit: 4 **3L – 1T – 0P**

Unit 1: Sources and types of radioactive waters: Uranium milling, conversion and enrichment facilities.
Unit 2: Reactor fuel fabrication, nuclear power reactors, nuclear reactor fuel reprocessing, radio nuclides used for medical and industrial applications.
Unit 3: Treatments methods, radioactive waste, Non-high level radioactive wastes and disposal of some radioactive elements, control and disposal legislation. Introduction to Noise source; Assessment and measurement of Noise, units.
Unit 4: Effects of Noise**,** Basic principles of noise control; Industrial and construction noise and control. Aircraft and airport noise and control, Highway and rail traffic noise and control.
Unit 5: Control of noise in the home, control of noise from recreational activities, methods of controlling noise.
Unit 6: Noise control legislation.

Reference Books:

1. *Dr Rosalie Bertell, "Nuclear Radiation and its Biological Effects", The Book Publishing Company, 1985.*
2. *Nuclear Pollution: An Exchange - by J. Kevin Branigan, David J. Brenner, Jay M. Gould,Alan Day Haight, Reply by M.F. Perutz, Volume 36, Number 21 · January 18, 1990.*
3. *S. Rosen and P. Olin, Hearing Loss and Coronary Heart Disease, Archives of Otolaryngology, 82:236, 1965.*
4. *J.M. Field, Effect of personal and situational variables upon noise annoyance in residential areas, Journal of the Acoustical Society of America, 93: 2753-2763 (1993)*
5. *"Noise Pollution". World Health Organisation. http://www.euro.who.int/Noise.*
6. *Report of the Committee appointed by Hon. Justice Smt. Sujata Manohar on Noise Pollution, (Distributed by Bombay Environmental Action Group, 4, Kurla Industrial Estate, Ghatkopar, Mumbai 400 086), 1986.*
7. *Noise Pollution Survey of Bombay "Scavenger April. 1982 and several other reports (SOCLEEN- Society for Clean Environment, 606E, Garden Resort, Sion Trombay Road, Chembur, Mumbai 400 071.*
8. *Calcutta High Court Judgement, 1996.*
9. *Karnataka High Court Judgement, 1996.*
10. *The Bombay Municipal Corporation Act, 1888.*
11. *Motor Vehicles Act, 1939.*

CE- 21356: Environmental Engineering Chemistry and Microbiology

Credit: 4 **3L – 1T – 0P**

Unit 1: Basic concepts from general chemistry; Basic concepts from physical chemistry.
Unit 2: Basic concepts from equilibrium chemistry.
Unit 3: Basic concepts from organic chemistry.
Unit 4: Basic concepts from colloidal chemistry.
Unit 5: Brief introduction to cell and cell structures, Classification of Microorganism, Microbial growth & metabolism.
Unit 6: Microbiology of water, wastewater and municipal solid waste treatment.

Reference Books:

1. Sawyer, C.N, Mc Carty, P.L. and Parkin, G.F, Chemistry for Environmental Engineering and Science, 5th Edn., Tata & McGraw-Hill Publishing Co. Ltd., New Delhi, 2003.
2. Stummn, and Morgan, J.J, Aquatic Chemistry, John Wiley & sons, New York, 1970.
3. Manahan, S.E, Fundamentals of Environmental Chemistry, Lewis Publishers, Boca Raton, 1993.
4. De. A.K. "Environmental Chemistry ", New Age International Ltd., New Delhi, 1995.
5. "Standard Methods for the Examination of Water and Wastewater ", 20th Ed., American.
6. Pelczar, Jr., M.J., Chan, E.C.S., Krieg, R. Noel., and Pelczar Merna Foss, " Microbiology ",5th Ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.
7. Stainer, R.Y., Ingrahum, J.L., Wheelis, M.C. and Painter, P.R. "General Microbiology" Mac Millan Ed., Ltd., London, 1989.
8. Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment, Disposal, and Reuse", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2007.

CE- 21357: Soft Computing Methods in Engineering Problem Solving

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction and Working Principles. Back ground, definitions, classification of soft computing techniques, advantages, limitations; Working principles of soft computing techniques- Fuzzy, ANN, genetic algorithms and other evolutionary techniques', examples in real life.
Unit 2: Fuzzy systems. Fuzzy sets, fuzzy numbers, fuzzy relations, fuzzy measures, fuzzy logic and the theory of uncertainty and information; applications of the theory to inference and control, clustering, image processing and data handling.
Unit 3: Artificial Neural Networks. Theory of representation; Two computational paradigms: Multi-layer networks; Auto associative and heteroassociative nets; Learning in neural nets: Supervised and unsupervised learning; Application of neural nets; Neural network simulators.
Unit 4: Genetic Algorithm. Genetic algorithm and Traditional optimization methods; Simple genetic algorithms- reproduction, crossover and mutation; Analysis of GA-operators; Deception; Working principles of genetic algorithms; Multimodel and multiobjective optimization; Engineering applications; Introduction with applications for Evolution strategy.
Unit 5: Hybrid Systems. Necessity, combined use of Fuzzy and ANN; Neuro-fuzzy systems, application of Neuro-fuzzy systems; Combined use of ANN-GA.
Unit 6: Applications. Case studies and general applications in engineering applications
Term Paper: Based on applications and/or algorithms development.

Reference Books:

1. *Bart, K., "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence", Prentice Hall. Barto, A. G. 1985.*
2. *Deb, K., "Evolutionary Multiobjective Optimization Algorithms" John Wiley & Sons Ltd., 2001.*
3. *Goldberg, D. E., "Genetic Algorithms in Search, Optimization and Machine learning", Addison-Wesley Publishing Co., 1989.*
4. *Haykin, S., "Neural Networks: A Comprehensive Foundations", Macmillan College Publishing Company, New York, 1994.*
5. *Ross, T.J., "Fuzzy Logic with Engineering Applications", McGraw-Hill Inc., 1995.*
6. *Zurada, J.M., "Introduction to Artificial Neural Systems", West Publishing Company, New York, 1992.*

CE- 21358: Solid and Biomedical Waste Management

Credit: 4 **3L – 1T – 0P**

Unit 1: Solid Waste. Definition and importance of management. Urban solid waste management scenarios. Waste generation. Physical, chemical and biological properties of MSW.

Unit 2: Onsite Storage and Collection. Calculation of storage requirement; container and truck size. Stationary and Hauled container system. Comparison of labor requirement, haul routes, equipment number, size and suitability for manual and mechanical collection systems.

Unit 3: Transfer and transport. Economics and preliminary design of transfer station, truck movement, compaction, recycling. Principles of MSW management. Processing and Recovery techniques; and related equipment. Recovery of resources and energy by mechanical separation, thermal and biological techniques. Preliminary design of composting facility. Process details of Material Recovery Facility. Working principle and design approach of recovery equipment.

Unit 4: Disposal of solid waste. Landfilling methods, Engineering principle of landfill design & its applications. Design of sanitary landfill leachate and off-gas collection system. Landfill liner system: material, cost, failure.

Unit 5: Biomedical waste. Categorization, collection, transport, treatment and disposal.

Unit 6: Municipal Solid Waste Management Rules, 2000 and Bio- Medical Waste (Management & Handling) Act, 1998.

Reference Books:

1. *Tchbanoglous, G., Theisan, H., and Vgils; Integrated solid waste management. McGraw Hill, New York, 1993.*
2. *Pavoni, J.L., "Handbook of solid waste disposal and management", Van Nostrand-Reinhold Co, USA, 1973.*
3. *Mantdl, C.L., "Solid waste management", John Wiley N.Y, 1975.*
4. *Dutta, S., "Environmental treatment technologies for Hazardous and Medical waste", Tata McGraw Hill, New Delhi, 2009.*
5. *CPHEEO, Manual on solid waste management, Ministry of Urban Development and Poverty Alleviation, Govt. of India, Delhi.*

CE- 21222: Environmental Quality Laboratory

Credit: 4 **0L – 0T – 6P**

Theory and laboratory procedures for determining the water quality, wastewater quality, and air quality parameters.

Water/Wastewater Quality Parameters:

1. Dissolved Oxygen (D.O.) in water/wastewater sample
2. Biochemical Oxygen Demand (BOD) in water/wastewater sample
3. Chemical Oxygen Demand (COD) in water/wastewater sample
4. Kjeldahl Nitrogen in water/wastewater sample
5. Fluoride in natural or treated water sample
6. Sulphate in water/wastewater sample
7. Oil and Grease in in water/wastewater sample
8. Chloride in water/wastewater sample
9. Iodide in water/wastewater sample
10. Chromium in water/wastewater sample
11. Arsenic in water/wastewater sample
12. Residual Chlorine in treated water/wastewater sample

Air Quality Parameters:

1. Mass concentration of suspended particulate matter (SPM) in ambient air by High Volume Air Sampler
2. Mass concentration of Sulphur Dioxide in ambient air (Wet Method) by High Volume Air Sampler
3. Mass concentration of Nitrogen Dioxide in ambient air (Wet Method) by High Volume Air Sampler

Reference Books:

1. *APHA, IWWAA, "Standard Methods for Examination of Water and Wastewater", 2005.*
2. *Sawyer, C.N, McCarty, P.L. and Parkin, G.F, "Chemistry for Environmental Engineering and Science", McGraw Hill, New York, 2003.*

CE- 21359: Remote Sensing and GIS

Credit: 4 **3L – 1T – 0P**

Unit 1: Fundamentals of Remote Sensing. Definition, Physics of remote sensing, Electromagnetic Radiations and their characteristics, Interaction phenomena with atmosphere and earth surface features, thermal emissions, Atmospheric windows, Spectral reflectance curves for earth surfaces features.

Unit 2: Sensors and Platforms. Multi-concept and Resolution in remote sensing, Classification and details of sensors and platforms, orbital characteristics, remote sensing satellites and data products.

Unit 3: Data Processing. Elements of photo-interpretation, FCC and visual interpretation, Introduction to digital image processing, applications of remote sensing in natural resources management, pollution studies and environmental impact assessment.

Unit 4: Introduction to GIS. Spatial and Non-Spatial data, Analog and digital representation, maps and their types, introduction to cartography, MIS and GIS, data inputs to GIS, components of GIS, Introduction to various GIS software packages.

Unit 5: Data Organization and Database Management. Data Structures, Data Input techniques, Geo-referencing of geographic data, GIS database and database management systems, creation of integrated geographic database.

Unit 6: Spatial Analysis. Selection of thematic layers, Data retrieval, Buffer analysis, Map Overlay, Concept of TIN and surface analysis, Application of GIS in environmental engineering, Selective case studies related to integrated GIS and remote sensing applications.

Reference Books:

1. *Lillies and T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation ", John Wiley and Sons, 1994.*
2. *Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information System", Narosa Publications, 2012.*
3. *Burrough, P.A. and McDonnell, R.A., "Principles of Geographical Information Systems ", Oxford University Press, 1998.*
4. *Lintz, J. and Simonet, " Remote Sensing of Environment ", Addison Wesley PublishingCompany, 1994.*

CE- 21360: Numerical Computation and Simulation

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction to MATLAB, C++, FORTRAN 90 and basic difference of each programme.
Unit 2: MATLAB: Advantages and disadvantages of MATLAB, Input and Output statement, loops, Iteration and floating types, Construction of arrays and matrices, MATLAB functions, plotting, debugging programs.
Unit 3: Solutions to the systems of linear equations and nonlinear equations; Numerical and curve fitting; Finite difference techniques.
Unit 4: Numerical Integration and differentiation- applied engineering problems and solving using MATLAB programming.
Unit 5: Ordinary differential equations- applied engineering problem and solving using MATLAB programming.
Unit 6: Engineering problems solving with MATLAB tools.

Reference Books:

1. *V. Rajaraman , "Computer Oriented Numerical Methods" Prentice Hall of India, , 2006*
2. *Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers" Tata McGraw Hill, New Delhi.*
3. *M. K. Jain, S. R. K. Iyenger and R. K. Jain, "Computational Methods for Partial Differential Equations", New Age International (P) Limited, 2003.*
4. *Andrew Knight, "Basics of MATLAB and beyond" Chapman & Hall/CRC, 2011.*
5. *Stephen J. Chapman, "MATLAB Programming for Engineers", Thomson Asia Pte. Ltd., Australia, 2008.*
6. *Delores M. Etter, "Engineering Problem solving with MATLAB", Prentice Hall, New Jersy, 1997.*
7. *Dean G. Duffy, "Advanced Engineering Mathematics with MATLAB" Chapman & Hall/ CRC Press, 2011.*
8. *S. R. Otto and J. P. Denier, "An Introduction to Programming and Numerical Methods in MATLAB", (Springer: New Age International), John Wiley and Sons, Inc., New York, 2002.*
9. *Won Y. Yang, Wenwe Cao, Tae Sang Chung, and John Morris, "Applied Numerical Methods using MATLAB" John Wiley & Sons, Inc., Publication, 2005.*

CE- 22121: Principles of Biological Wastewater Treatment

Credit: 4 **3L – 1T – 0P**

Unit 1: Wastewater characterization: Analysis of BOD, COD and other parameters.
Unit 2: Unit operations, Reaction Kinetics, types of reactors and reactor dynamics, analysis of ideal and field reactors.
Unit 3: Bio- kinetic parameters and their evaluation, Biomass yield, Cell maintenance energy considerations.
Unit 4: Principles of oxidation in Stabilization ponds, ASP, Trickling filter, Aerated lagoons and RBCs. Principles of aerobic and anaerobic processes and design consideration, design model and equations. Principles of nitrification, denitrification & anoxic processes.
Unit 5: Mass transfer, diffusion and attached growth processes.
Unit 6: Principles of sludge stabilization and chemical oxidation, principle and design of sludge digestion.

Reference Books:

1. *Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment, Disposal, and Reuse", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
2. *Weber, "Physico-Chemical Process for Water Quality Control", John Wiley and Sons, New York, 1977.*
3. *Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill Book Co., International Ed., 1985.*
4. *Fair, Geyer and Okun, "Waste Water Engineering, Vol.-I and II" John Wiley Publications New York, 1966.*
5. *Arceivala, S. J., "Wastewater Treatment for Pollution Control" 2nd Ed. 3rd Reprint, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2002.*
6. *Gray, N. F., "Water Technology", Ist Indian Ed., Viva Books Pvt. Ltd., New Delhi, 2000.*

CE- 22221: Advanced Environmental Engineering Laboratory

Credit: 4 **0L – 0T – 6P**

1. Method for the determination of Chromium (VI) in water/wastewater sample.
2. Method for the determination of Iron (II) in natural or treated waters.
3. Method for the determination of Manganese (II) in natural or treated waters.
4. Method for the determination of Nitrogen (Nitrate) in water/wastewater sample.
5. Method for the determination of Phosphorus in water/wastewater sample.
6. Method for the determination of Coliform (Total and Faecal) density in water/wastewater sample.
7. Kinetics and equilibrium adsorption study of heavy metal from aqueous solutions onto powdered activated carbon
   a. Evaluate the effects of initial metal concentration, solution pH, contact time and adsorbent dose
   b. Development of adsorption Isotherms and fitment of equilibrium data to suitable isotherm model(s)
8. Determination of the effect of toxicants on the BOD degradation rate constant to quantitatively establish toxicity (EC_{50}) against activated sludge microorganisms.

Demonstration and use of advance instruments (Spectrophotometer, AAS, Flame photometer, GC, etc. for analyses of water/wastewater samples.

Reference Books:

1. *APHA, IWWAA, "Standard Methods for Examination of Water and Wastewater", 2005.*
2. *Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment ", Disposal and Reuse, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
3. *Willard. H., Merritt, L., Dean. D.A. and Settle. F.A. "Instrumental methods of analysis ", 7th Edition, CBS Publishers, New Delhi, 2012.*
4. *Ewing, C.W. "Instrumental Methods of Chemical Analyser", 5th Ed., McGraw-Hill, 1995.*

CE- 22351: Biochemistry and Microbiology

Credit: 4 **3L – 1T – 0P**

Unit 1: Chemistry of Biological Compounds: Carbohydrates, Lipids, Amino-acids and proteins, nucleic Acids and their components.
Unit 2: Metabolism of Biological compounds: Biochemical enzymes, Vitamins and Coenzymes, Anaerobic Carbohydrate Metabolism pentose phosphate Pathway, TCA Cycle, electron transport and oxidative phospherylisation, Lipid Metabolism and metabolism of Amino-acids and proteins.
Unit 3: Integration of Metabolism: Integration of Carbohydrates, Lipids and proteins metabolism, photosynthesis, nitrogen cycle, carbon cycle.
Unit 4: Introduction to Cell structures.
Unit 5: Microbiology of water and wastewater treatment technology.
Unit 6: Microbiology of solid wastes, Aeromicrobiology.

Reference Books:

1. *Sawyer, C.N, McCarty, P.L. and Parkin, G.F, Chemistry for Environmental Engineering and Science, 5th Ed., Tata & McGraw-Hill Publishing Co. Ltd., New Delhi, New Delhi, 2003.*
2. *Manahan, S.E, Fundamentals of Environmental Chemistry, Lewis Publishers, Boca Raton, 1993.*
3. *De. A.K. "Environmental Chemistry ", New Age International Ltd., New Delhi, 1995.*
4. *APHA, IWWAA, "Standard Methods for Examination of Water and Wastewater", 2005.*
5. *Pelczar, Jr., M.J., Chan, E.C.S., Krieg, R. Noel., and Pelczar Merna Foss, "Microbiology", 5th Ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.*
6. *Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment, Disposal, and Reuse", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
7. *Brock, T.D. and Madigan, M. T. (1988), "Biology of Microorganisms" 5th Ed., Prentice Hall, London, 1988.*

CE- 22352: Design of Water and Wastewater Systems

Credit: 4 **3L – 1T – 0P**

Unit 1: Design of water treatment system, intake structure, PST, Mechanical rapid mixing devices and Flocculators, Sedimentation tanks, Filters and Disinfection, etc.
Unit 2: Design of Sewerage system and Drainage system.
Unit 3: Design of wastewater treatment system, Trickling filters, Activated Sludge Process, Extended Aeration systems, Stabilization ponds, Lagoons.
Unit 4: Design criteria of Anaerobic Biological Reactors including Anaerobic Filter, UASBR, etc.; sludge digesters and sludge beds.
Unit 5: Application of software in design of water and wastewater systems like SewerGEMS, WaterGEMS, etc.
Unit 6: Case Studies (Complete design of water and wastewater systems).

Reference Books:

1. *Rich, L.G. "Unit Processes in Sanitary Engineering ", John Wiley & Sons, Inc., New York, 1963.*
2. *Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment, Disposal, and Reuse ", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
3. *Arceivala, S. J. (2002), "Wastewater Treatment for Pollution Control" 2nd Ed. 3rd Reprint, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.*
4. *Gray, N. F., "Water Technology", Ist Indian Ed., Viva Books Pvt. Ltd., New Delhi, 2000.*
5. *Qasim, S.R., "Wastewater Treatment Plants – Planning, Design and Operation", Holt, Rinehart and Winston Publisher, New York, 1985.*
6. *CPHEEO, "Manual on water supply and Treatment," Ministry of Urban Development, GOI, New Delhi, 1999.*
7. *CPHEEO, "Manual on Sewerage and Sewage Development ", Ministry of Urban Development, GOI, New Delhi, 1993.*

CE-22308: Finite Element Methods

Credit: 4 **3L-1T-0P**

Unit 1. Brief introduction to numerical methods.
Unit 2. Different Approaches, Direct method, Energy approach, Integral formulations and Variational methods.
Unit 3. Modeling, Interpolation functions, Numerical integration and modeling considerations.
Unit 4. Applications**,** Finite element analysis of 1-D and 2-D problems.
Unit 5. Applications and Error Analysis, Application of the method to the axisymmetric and 3-D bodies, Finite element error analysis.
Unit 6. Dynamic Considerations**,** Eigen value and time-dependent problems.

References:

1. *K. J. Bathe & E. L. Wilson, Numerical Methods in Finite Element Analysis, Prentice-Hall, Englewood Cliffs, N. J., 1976.*
2. *R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley, New York, 2001.*
3. *C. Zienkiewicz and R. L. Taylor, Finite Element Method, Butterworth Heinemann publication, 3rd Edition, 2005.*
4. *Thomas J. R. Hughes, The Finite element method, Dover Publications, 2nd Edition, 2000.*
5. *T. R. Chandupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999.*
6. *J. N. Reddy, An Introduction to Linear Finite Element Method, Oxford University Press, Oxford, 2004.*

CE-22309: Structural Design of Environmental Engineering Systems

Credit: 4 **3L-1T-0P**

Unit 1: Hydraulic design of various liquid retaining structures.
Unit 2: Concept of various shapes for liquid retaining structures.
Unit 3: Design of container, Staging and Foundations for tanks.
Unit 4: Design of Ferro cements tanks.
Unit 5: Introduction to pre-stressed Concrete tanks.
Unit 6: Design of pipes for various load conditions.

References:

1. *Plain and Reinforced Concrete vol. II- Jai Krishna and O. P. Jain*
2. *Reinforced Concrete Design-P. Dayaratanam*
3. *IS: 3370 Indian Code of Practice for Water Retaining Structures*
4. *A.K.Jain.- Reinforced concrete (Limit State Design)*

CE- 22353: Industrial Wastewater Treatment and Reuse

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction. Industrial wastewater versus municipal wastewater, Uses of water by industry, Sources and types of industrial wastewater, Industrial wastewater disposal and environmental impacts, Reasons for treatment of industrial wastewater, Effects of waste on watercourses and wastewater treatment plants, Computation of Organic Waste Loads on Streams, Stream Protection Measures, Stream and Groundwater Sampling.

Unit 2: Theories. Volume and Strength reduction; Neutralizations; Equalization and Proportioning.

Unit 3: Case Studies. Industrial manufacturing process description, wastewater characteristics and Treatment flow sheet for industries like Textiles, Tanneries, Pulp and Paper, Electroplating, Petroleum Refining, Chemical, Pharmaceuticals, Sugar and Distilleries, Dairy, Iron and Steel, Fertilizer, etc. Treatment techniques for specific pollutants in industrial effluents, e.g. oil & grease, phenol, cyanide, chromium, toxic organics.

Unit 4: Advanced Wastewater Treatment. Chemical oxidation, Wet Air Oxidation, Ion exchange, Membrane technologies, Wastewater Nutrients removal. Industrial Wastewater Recycle, Reuse and Reclamation in industries.

Unit 5: Applications. Joint treatment of raw or partially industrial waste with domestic sewage, Discharge of completely treated wastes to municipal sewer systems, Discharge of partially and completely treated waste to streams.

Unit 6: Zero Discharge Concepts. Introduction to Industrial Ecology, Industrial Symbiosis, Material flow analysis.

Reference Books:

1. *Nemerow, N. L. and Agardy, F. J., "Strategies of Industrial and Hazardous Waste Management," 2nd Edition, Van Nostrand Reinhold Company, USA, 1998.*
2. *Patwardhan, A. D., "Industrial Waste Water Treatment," PHI Learning Pvt. Ltd., 2008.*
3. *Ranade, V. V. and Bhandari, V. M., "Industrial Wastewater Treatment, Recycling and Reuse," Butterworth-Heinemann, Elsevier, UK, 2014*
4. *Eckenfelder, W.W., "Industrial Water Pollution Control ", McGraw Hill, 1999.*
5. *Arceivala, S.J., "Wastewater Treatment for Pollution Control ", Tata McGraw Hill, 1998.*
6. *Metcalf & Eddy, Inc. "Wastewater Engineering - Treatment, Disposal, and Reuse", Seventh Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
7. *Rao, M.N. and Datta, A.K., "Wastewater Treatment- Rational Methods of Design and Industrial Practices" 2nd Ed., Oxford and IBH Publishing Co. Pvt. Limited, New Delhi, 1987.*
8. *Mahajan, S.P., "Pollution Control in Process Industries", 2nd Reprint, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1990.*

CE- 22354: Air and Water Quality Modelling

Credit: 4 **3L – 1T – 0P**

Unit 1: Role of mathematical models; kinds of mathematical models - model development and validation, effluent and stream standards; ambient air quality standards.
Unit 2: Rivers and streams water quality modelling - 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.
Unit 3: water quality modelling process - model sensitivity - assessing model performance; Models for dissolved oxygen, pathogens; Streeter - Phelps models.
Unit 4: 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.
Unit 5: Air pollution modelling and prediction - Plume rise, modelling techniques, modelling for nonreactive pollutants, single source -short term impact; multiple sources and area sources; model performance, accuracy and utilization; computer models.
Unit 6: Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement. Exposure to computer models and software for surface water quality, groundwater quality and air quality.

Reference Books:

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

CE- 22355: Chemodynamics

Credit: 4 **3L – 1T – 0P**

Unit 1: Ideal Solutions-air-water equilibrium occurrences-pure gases in contact with water-pure liquid in contact with air partition coefficient for the air water system. Earthern solid-water equilibrium occurrences-pure solid and liquid chemical in contact with water and earthern solids. Earthern solid-air equilibrium occurrences-water-liquid chemical equilibrium occurrences-thermal equilibrium at environmental interfaces.

Unit 2: Diffusion and mass transfer-molecular diffusion-eddy diffusion-mass transfer theories-mass transfer coefficients; binary mass transfer coefficients in two phases and two resistance theory of interphase mass transfer turbulence in the environment-fundamentals of heat transfer-analogy theories of momentum, heat and mass transfer.

Unit 3: Desorption of gases and liquids from aerated basins and rivers-completely mixed basin-plug flow basin-gas exchange rates between the atmosphere and the surface of river-exchange of chemical across the air-water interface of lakes and Oceans.

Unit 4: Dissolution of chemicals on the bottom of flowing streams-geometric forms-stream bottom mass transfer coefficients- natural convection dissolution-the upsurge of chemicals-from the sediment-water interface of lakes-a Fikian analysis-annual upsurge rate at sediment-water interface.

Unit 5: Mass transfer coefficients at the sediment-water interface. Flux of chemical between sediment and the overlying seawater-movement of chemicals through the benthic boundary layer.

Unit 6: Turbulence above the air-soil interface-the Richardson number-Chemical flux rates through the lower of the Layer of the atmosphere-Thronthwaite-Holzman equation-evaporation of liquid chemicals spilled on land- Chemical flux rates through the upper layer of earthern material.

Reference Books:

1. *Thibodeaux, L.J., "Chermodynamics: Environmental Movement of Chemicals in Air, Water, and Soil ", John Wiley & Sons, New York, 1994.*
2. *Cussler, E.L. "Diffusion: Mass Transfer in Fluid Systems ", Cambridge University Press, 1994.*

CE- 22333: Geo-Environmental Engineering

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction, Soil-waste Interaction, Geosynthetics - An Introduction. Erosion Control and Land Management.
Unit 2: Design and Construction of Landfills for Municipal and Hazardous Waste, Design of Mine tailings Disposal Facilities and Flyash Disposal Facilities.
Unit 3: Detection and Monitoring of Subsurface Contamination Including Instrumentation, Introduction of Remediation Technologies.
Unit 4: Environmental Protection, Earth Structure.
Unit 5: Design of Hazardous Waste and Nuclear Waste Repositories in Rock.
Unit 6: Geotechnical Reuse of Waste Material, Control and Regulation, Subsidence and Heaving, Case Studies.

Reference Books:

1. *"Geotechnical Practices for Waste Disposal", D.E. Daniel (Ed.), American Society of Civil Engineers, New York, 1973.*
2. *"Encyclopedia of Environmental Control Techniques," H.T. Fang (Ed.), 1992.*
3. *Bagchi, A. "Design Construction and Monitoring and Landfills", John Wiley & Sons, New York, 1974.*
4. *Oweis, I.S. and Khera, R.P., "Geotechnology of Waste Management", PWS Publishing Company, Boston, 1998.*
5. *Pusch, R., "Waste Disposal in Rocks", SKB, Stockholm, 1992.*
6. *Rowe, R.K., Quigley, R.M., Booker, J.R.E. and Spoon, F.N. "Clay Barrier System for Waste Disposal Facilities", London, 1995.*
7. *Rao, G.V. and Raju, G.V.S.S., "Engineering with Geosynthetics", Tata McGraw Hill Publishing Co., New Delhi, 1992.*
8. *Tripathi R.P. and Singh, H.P., "Soil Erosion and Conservation", New Age Publishers, 1993.*
9. *Ritcay, G.M., "Tailings Management", Western Australia, 1989.*
10. *Goumans, J.J.M., Vanderstoot H.A. and Albert, T.S., "Environmental Aspects of Construction with Waste Material", Elsevier Science, 1991.*

CE- 22356: Hazardous Waste Management

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction. Sources, Hazardous waste characteristics and quantification.

Unit 2: Impact of Hazardous waste on Environment. Contaminant transport in surface and sub-surface water bodies, Soil contamination, Contaminant attachment and detachment mechanisms.

Unit 3: Waste Minimization. Source reduction, Reuse and Recycling, On-site and Off-site recovery and recycling, Process change, Recent technologies and other waste minimization options, Waste transport and storage- Regulatory requirements, Wastewater compatibility issues.

Unit 4: Treatment. Physico-chemical and biological treatment methods, Incineration, On-site v/s Off-site Treatment, Case studies of specific waste treatment, Advanced hazardous waste.

Unit 5: Disposal. Engineered design and planning for landfills, Pre-treatment requirements, Site selection, Leachate and off-gas management, Post closure Monitoring and Management, Remediation of Contaminated Sites- Assessment of the extent of contamination, Remediation measures.

Unit 6: Protection from spread of pollutants, planning for site remediation, Hazardous Waste (Management & Handling) Rules, 1989.

Reference Books:

1. *LaGrega, M.D., Buckingham, P. L. and Evans, J. C., "Hazardous Waste Management," Second Edition, Waveland Press Inc., USA, 2010.*
2. *Tchbanoglous, G., Theisan, H., and Vgils; Integrated solid waste management. McGraw Hill, New York, 1993.*
3. *Charles A. Wentz; "Hazardous Waste Management ", McGraw-Hill Publication, 1995.*
4. *CPHEEO; Manual on solid waste management, Ministry of Urban Development and Poverty Alleviation, Govt. of India, Delhi.*

CE- 22357: Groundwater Contamination and Pollution Transport

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction Groundwater as a Resource. Ground water as a resource-Ground water contamination-Ground water as a Geotechnical problem-Ground water and geologic processes. Physical properties and principles-Darcy's Law-Hydraulic Head and Fluid Potential-piezometers and Nests. Hydraulic conductivity and permeability- Homogeneity and Anisotropy-porosity and voids Ratio-Unsaturated flow and the water table-Steady state flow and Transient Flow-compressibility and effective stress- Transmissivity and Storativity -Equations of Ground water flow-Limitations of Darcy's Approach-hydro dynamic dispersion.

Unit 2: Hydrologic Cycle and Flow-net. Ground water and the hydrologic cycles, Flow nets-Graphical construction-Flow nets by numerical simulation, steady state Regional Ground water Flow- Steady state hydrologic-budgets-Fluctuations in ground water levels.

Unit 3: Resource Evaluation. Development of Ground water Resources-Exploration for Aquifers-the response of Ideal aquifers to pumping- Measurement of parameters -Laboratory tests-Piezometer test-pumping tests-Estimation of saturated hydraulic conductivity-Numerical simulation for aquifer yield prediction-Artificial recharge and induced infiltration-Land subsidence-sea water intrusion.

Unit 4: Chemical Properties and Principles. Constituents-chemical equilibrium-Association and Dissociation of dissolved species-effects of concentration Gradients-Mineral dissolution and solubility-Oxidation and Reduction Process-Ion exchange and Adsorption- Environmental isotopes-Field Measurement of Index parameters. Chemical Evolution: Hydro Chemical Facies-Ground water in carbonate terrain-Ground water in crystalline rocks-Ground Water in complex sedimentary systems-Geochemical interpretation of 14C Dates-process rates and molecular diffusion.

Unit 5: Solute Transport. Water quality standards-Transport process-non-reactive constituents in homogeneous media and Heterogeneous media-Transport in Fracture media-Hydro-chemical behaviour of contaminants-Trace metals-Nitrogen-Trace non-metals organic substances-Measurement of parameters-velocity-dispersivity-chemical partitioning-Sources of contamination-Land disposal of solid wastes-Sewage disposal on Land.

Unit 6: Modelling Principles and Software. Modelling principles-1D, 2D, and 3D modelling, MOC Modelling, USGS-MOC MODEL**,** Visual MODFLOW.

Reference Books:

1. Charbeneau, Randall J. "Ground Water Hydraulics and Pollutant Transport", Waveland Press Inc., USA, 2000.

2. Freeze, Allen R. and Cherry, John A. "Ground Water ". Prentice Hall Inc., 1979.

3. *Todd, D. K., Ground water Hydrology, John Wiley & Sons, New York, 1995*

CE- 22358: Environmental Impact Assessment

Credit: 4 **3L – 1T – 0P**

Unit 1: Overview of EIA; EIA at different levels: Regional; policy; sector levels, EIA process; Screening and scoping criteria.

Unit 2: Rapid and comprehensive EIA; Legal and Regulatory aspect in India; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties.

Unit 3: Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation Plans.

Unit 4: Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical; biological and socio-economic environment.

Unit 5: Environmental management plan; Post project monitoring, Environmental Audit, EIA report and EIS; Review process.

Unit 6: Case studies on EIA projects and Environmental Management Plan.

Reference Books:

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- 22359: Management and Modelling of Environmental Systems

Credit: 4 **3L – 1T – 0P**

Unit 1: Introduction. Human - environment relationship, normative criteria, descriptive and prescriptive models, limits of growth.

Unit 2: Environmental economics and Laws. Environmental and natural resources economics, pollution control policy, growth in a finite environment, Environmental protection laws.

Unit 3: Numerical/mathematical Modelling. Numerical/mathematical modelling of environmental systems, subsystems, and pollutant transport processes.

Unit 4: Planning and Management of Environmental Systems. Planning and management of environmental systems: optimization techniques, stochastic modelling, statistical inferences, Large scale systems.

Unit 5: Monitoring Network. Necessity, optimal monitoring network design, identification of sources.

Unit 6: Risk Reliability and Uncertainty. Risk reliability and uncertainty in environmental systems; its quantification. Case studies in groundwater and surface water quality management.

Reference Books:

1. *Charbeneau, Randall J., "Ground Water Hydraulics and Pollutant Transport ", Waveland Press Inc., USA, 2000.*
2. *Freeze, Allen R. and Cherry, John A., "Ground Water ". Prentice Hall Inc., 1979.*
3. *Subramanya, K. "Engineering Hydrology", 2nd Ed., Tata McGraw-Hill Pub. Co., New Delhi, 1994.*