

M. Tech. (Environmental Engineering and Management)

DETAILED SYLLABUS

For
Environmental Engineering and Management
R.16



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

| | | |
|------------|--|---|
| I-I | ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS | L / P / Credits 4 / -- / 3 |
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Unit-I: Numerical Integration and Differentiation

Newton-Cotes Integration Formulas: The Trapezoidal rule, Simpson's rules, Integration with unequal Segments, Open Integration Formulas, Multiple Integrals.

Integration of Equations: Newton-Cotes Algorithms for Equations, Romberg Integration, Adaptive Quadrature, Gauss Quadrature, Improper Integrals.

Numerical Differentiation: High-Accuracy Differentiation Formulas, Richardson Extrapolation, Derivatives of Unequally Spaced Data, Derivatives and Integrals for Data with Errors, Partial Derivatives, Numerical Integration/Differentiation with Software Packages.

Unit-II: Ordinary Differential Equations

Explicit and Implicit Forms of Difference Equations, Taylor's and Euler's Methods, Runge-Kutta Methods, Systems of Equations, Adaptive Runge-Kutta Methods, Stiffness of ODEs & Multi step methods, Gear's Algorithm, Finite Difference Technique for Boundary Value Problems (BVP), derivative boundary conditions, convergence and stability of finite difference schemes.

Unit-III: Partial Differential Equations

Finite Difference approximations.

Finite difference methods – Elliptic equations: Laplace equation, Solution Technique, Boundary Conditions, The Control-Volume Approach.

Finite Difference methods- Parabolic Equations: The Heat-Conduction Equation, Explicit Methods, A Simple Implicit Method, The Crank-Nicolson Method, Parabolic Equations in Two Spatial Dimensions.

Unit-IV: Finite element method

Finite-Element Method: The General Approach, Finite-Element Application in One Dimension Two-Dimensional Problems, Solving PDEs with Software Packages.

Unit-V: Application of Statistical Methods

Joint probability distributions, marginal distributions, conditional distribution, statistical independence.

Reliability applications: Failure rate, exponential law, Weibull law, Reliability of a component, system reliability, parallel and series reliability.

Text Book:

1. "Numerical methods for engineers"; Steven C. Chapra, Raymond P. Canale; McGraw Hill higher education, 6th edition, 2010.
2. "Probability and Statistics for Engineers and Scientists"; Ronald E. Walpole, Sharon L. Myers and Keying Ye; Pearson, Eighth edition.

Reference books:

1. "Mathematical Methods in Chemical Engineering"; Jenson V.G. and Jeffreys G.V; Academic press, 2nd edition.
2. "Advanced Engineering Mathematics"; Erwin Kreyszig, Wiley-India publication, 8th edition.
3. "Introductory Methods of Numerical Analysis", Sastry S.S; 4th Edition, PHI Learning Pvt. Ltd., 2006.

| | | |
|------------|--|------------------------------------|
| I-I | Unit Operations and Processes in Water and Wastewater Treatment | L / P /Credits 4/-- / 3 |
|------------|--|------------------------------------|

UNIT I

Characteristics of Water and Wastewater: Physical, Chemical and Biological Characteristics of water, domestic and industrial wastewater – Comparison between municipal and industrial wastewater characteristics- Stages in treatment systems - Conventional treatment flow diagrams of water and wastewater treatment

Physical Unit Operations: Theory, functions and design criteria: Screening, Grit removal, Equalization, Sedimentation, Flotation, filtration, Aeration and gas transfer, freezing

UNIT II

Chemical Unit Processes: Neutralization, coagulation and flocculation, disinfection, Chemical oxidation and precipitation, Heavy metal removal, Oil separation, adsorption, Photo catalysis – Wet Air Oxidation – Evaporation, – Ion Exchange - Application of Membrane Processes, Reverse Osmosis, Micro-filtration, Nano-filtration, Ultrafiltration and Electrodialysis , Control of odour, Control of volatile organic compounds.

UNIT III

Biological Unit Processes: Principles & Objectives of biological treatment-significance - aerobic and anaerobic treatment- kinetics of biological growth - factors affecting growth – attached, suspended and Hybrid growth systems. Determination of kinetic coefficients for organics removal – Biodegradability assessment – selection of process – reactors– Types of Reactors

UNIT IV

Aerobic Treatment of Wastewater: Design and construction aspects and the relevant parameters of significance of the units: Activated Sludge Process, Trickling Filters, Aerated Lagoons, Rotating Biological Contactors, Sequential Batch Reactors (SBR), Stabilization ponds, Hybrid reactors for the treatment of wastewater : IFAS, MBBR, MBR, Expanded / fluidized bed bio reactors, Nutrient removal.

UNIT V

Anaerobic Treatment of Wastewater: Sludge handling and treatment -Sludge digestion: theory and principles - Disposal of digested sludge, Anaerobic ponds, UASB reactors and various modifications in UASB process and anaerobic filters. Two stage /phase reactors – biogas plants.

Reference Books

1. Metcalf & Eddy, Inc. *Wastewater Engineering, Treatment and Reuse*. 4th Edition, Tata McGraw Hill, New Delhi, 2003.
2. Benefield, L.D. and Randall C.W. *Biological Processes Design for wastewaters*, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.
3. Grady Jr. C.P.L and Lin H.C. *Biological wastewater treatment: Theory and Applications*, Marcel Dekker, Inc New York, 1980.

I – I INDUSTRIAL WASTEWATER MANAGEMENT L / P / Credits
4 / -- / 3

UNIT I

Introduction: Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents.

UNIT II

Pollution Prevention & Unit operations: Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy – Source & reduction techniques – Strength& volume Reduction - Material balance - Evaluation of Pollution prevention options - Waste minimization Circles.

UNIT III

Wastewater Reuse and Residual Management: Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Management of RO rejects.

UNIT-IV

Manufacturing process and sources of effluent from the process of industries like fertilizer, pulp and paper, sugar, distillery, tannery, food processing, dairy and Pharmaceuticals, Industrial manufacturing process description, wastewater characteristics, and source reduction options

UNIT-V

Manufacturing process and sources of effluent from the process of industries like: Steel, Petroleum Refineries, Textiles, Atomic Energy Plants, Metal finishing and other Mineral Processing Industries. Industrial manufacturing process description, wastewater characteristics, and source reduction options

Reference Books:

1. W. Wesley Eckenfelder Jr., Industrial Waste Water Pollution Control.
2. Arceivala, S.J., and Asolekar Wastewater Treatment for Pollution Control, McGraw-Hill, 1998.
3. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
4. M.N. Rao &A.K. Datta, Waste water treatment.
5. Nelson Leonard Nemerow, “Industrial waste treatment – contemporary practice and vision for the future”, Elsevier, Singapore, 2007
6. Hardam S. Azad, (ED), Industrial Wastewater Management Hand Book 1988.
7. Indian standards: IS: 2490 (1963), IS: 3306 (1065).
8. Paul L. Bishop, ‘Pollution Prevention: - Fundamentals and Practice’, Mc-Graw Hill International, Boston, 2000.

**I - I ENVIRONMENTAL HYDROLOGY AND HYDRAULICS L / P / Credits
4 / -- / 3**

Unit I : Introduction - Statistical analysis of Hydrological Data - Rainfall and Runoff estimation, Intensity–Duration frequency Curves, Draft storage with different risks.

Unit II : Hydraulics of ground water flow - Non–equilibrium flow, Yield estimations, Interferences - Infiltration galleries, ground water recharge- principles of water shed management

Unit III : Transportation of water - Storage capacity, Pumping of Water, Design and selection of economical diameter of pumping main – open channel flow – design of open channel flow sections.

Unit IV : Distribution of Water - Pressure and capacity requirements of distribution system, Analysis of networks, Appurtenances in a distribution layout, detection and prevention of leakage mains.

Unit V : Hydraulics of Sewers - Sewers and its appurtenances - Design of sewers in full and partial flow conditions, Flow at Sewer transitions, Sewage pumping.

- Reference Books:
1. Water and Wastewater Engineering by Fair, Gayer and Okun
 2. CPHEEO Manual on water supply & treatment
 3. CPHEEO Manual on Sewage & Sewerage Systems

I – I REMOTE SENSING & GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING

(Elective-I)

L / P / Credits

4 / -- / 3

UNIT I

Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Electromagnetic Spectrum - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing, Fundamentals of Microwave Remote Sensing. Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections – Basic Pattern Recognition Concepts, Basic Principles of Visual Interpretation

UNIT II

Fundamentals of GIS – Information Systems, Modelling Real World Features Data , Data Formats – Spatial and Non-spatial, Components, Data Collection and Input, Data Conversion, Database Management – Database Structures, Files; Standard Data Formats, Compression Techniques, Introduction to Standard Packages like Arcview, ArcGIS, Map Info etc.

UNIT III

Spatial Analysis and Modelling – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Spatial Auto Correlation, Gravity Modelling, DTM/DEM, Integration with Remote Sensing data

UNIT IV

Geospatial techniques for planning and design of Water-Supply and Irrigation Systems, Spatial Database Development for Wastewater and Storm water Systems, Geospatial technologies for Water Resources Monitoring and Forecasting; Spatial Decision-Support Systems in River Basin Management; Spatial systems for floodplain mapping and management, GIS for Water and Air Quality Management Decision Support

UNIT V

Taxonomy of Environmental Models in the Spatial Sciences. Geographic Data for Environmental Modeling and Assessment. Applications of Remote Sensing and Geographic Information Systems in Wildlife Mapping and Modeling. Land Use Planning and Environmental Impact Assessment Using Geographic Information Systems

1. Agarwal, C. S., and Garg, P. K., *Textbook on Remote Sensing in Natural Resources Monitoring and Management*, Wheeler Publishing , Allahabad, 2000
2. Lillesand, T. M., and Keifer, R. W., *Remote Sensing and Image Interpretation*, John Wiley & Sons, N York, 1994
3. Meijerink M. J., de Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., *Introduction to the Use of Geographical Information Systems for Practical Hydrology*, ITC publication no. 23, UNESCO, Paris, 1994
4. Swain, P. H., and Davis, S. M., *Remote Sensing – The Quantitative Approach*, McGraw Hill Pub. Co. N York, 1987

I – I ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY L / P / Credits
(Elective -I) 4 / -- / 3

Unit-I

Basics of colloidal chemistry – Redox potentials – partition co-efficient – Beer – Lambert’s Law – Limitations – adsorption – principles – Principles of green chemistry - UV visible spectroscopy - basic principles – application – Flame Photometry - Atomic absorption spectroscopy – Principles – applications, Gas chromatograph and HPLC – Principles and applications.

Unit-II

Equilibrium Constants, Le-Chatelier Principle, Transport and transformation of chemicals – Photo catalysis - Soil chemistry - acid-base and ion-exchange reactions in soil - salt affected soil and its remediation – Principles of biochemistry.

Unit-III

Classification of microorganisms- prokaryotic, eukaryotic, structure, characteristics, nucleic acids - DNA, RNA, replication. Culturing of microorganisms - Environmental factors influencing microbial growth and kinetics. Microbiology of biological treatment processes.

Unit-IV

Distribution of microorganisms - Water, Air and Soil, Indicator organisms, coliforms—fecal coliforms, E-Coli, Streptococcus, Clostridium, Significance in water. Algae in water supplies—problems and control, MPN and MFT.

Unit-V

Eco-toxicology— toxicants and toxicity, factors influencing toxicity, effects—acute, chronic, concentration response relationships, test organisms, toxicity testing, bio-concentration, bio-accumulation, bio-magnification, bio-assay, bio-monitoring.

Reference books:

1. C.N. Sawyer, P.L. McCarty and G.F. Perkin, Chemistry for Environmental Engineering and Science, Tata McGraw Hill, Fifth edition, New Delhi, 2003.
2. Microbiology for sanitary engineers by McKinney
3. Microbiology for Scientists and Engineers by Gaudy & Gaudy.
4. Microbiology by Pelzer, Ecschan & N R Kreig.

I – I CLIMATE CHANGE AND GLOBAL ENVIRONMENTAL ISSUES L / P / Credits
(Elective -I) 4 / -- / 3

UNIT I: EARTH'S CLIMATE SYSTEM

Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains – Storms and Hurricanes – The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation –The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

UNIT II: OBSERVED CHANGES AND ITS CAUSES

Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC –Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.

UNIT III: IMPACTS OF CLIMATE CHANGE

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

UNIT IV: CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

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

UNIT V: CLEAN TECHNOLOGY AND ENERGY

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

Reading:

1. Anil Markandya , *Climate Change and Sustainable Development: Prospects for Developing Countries*, Routledge, 2002
2. Heal, G. M., *Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty*, Kluwer Academic Publ., 1998
3. Jepma, C.J., and Munasinghe, M., *Climate Change Policy – Facts, Issues and Analysis*, Cambridge University Press, 1998
4. Munasinghe, M., *Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective*, Kleindorfer P. R. et al (ed.), Edward Elgar, 1996
5. Dash Sushil Kumar, “Climate Change – An Indian Perspective”, Cambridge University Press India Pvt. Ltd, 2007

I – I

**BIOREMEDIATION
(Elective -II)**

**L / P / Credits
4 / -- / 3**

UNIT I

Bioremediation: Definition – Principles of bioremediations, Factors of bioremediation-Bio augmentation for bioremediation, Bioreactors.

UNIT II

Bioremediation strategies – remediation technologies - in situ and ex situ bioremediation- advantages and disadvantages of bioremediation- Phytoremediation Technology for Soil Decontamination

UNIT III

Microbial systems for bioremediation- genetic responses of microorganisms to the presence of pollutants- application of genetically engineered microorganisms for waste management- Biological Treatment Technologies for Metals Remediation -Bioleaching and Biobenification - Bioaccumulation

UNIT IV

Microbial transformation reactions- microbial detoxification- bioremediation systems and processes-microbial cleaning of gases- insitu bioremediation - lab scale bio treatability- Oxidation/Reduction Processes -Biological Methylation -Case studies

UNIT V

Bioremediation of herbicides, pesticides, hydrocarbons, oil spills. – Bioremediation of organic and inorganic pollutants-advances in microbial remediation- Sequestering Carbon Dioxide -Bio monitoring -Application of Microbial Enzymes -Bio membrane Reactors

Books

1. Atlas R.M. and Philip J (Eds): Bioremediation: Applied microbial solutions for real world environment clean up I edition. Amer Society of Microbiology, 2005
2. Ergas S.J., Chang, B.P.Y. Schreoder, E.D. and Eweis. J.B. Bioremediation principles, WCB/ McGraw Hill, 1998

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| I-I | ENVIRONMENTAL LEGISLATIONS AND MANAGEMENT SYSTEMS (Elective-II) | L / P / Credits 4 / -- / 3 |
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UNIT I

Introduction : Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – National and International multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration etc – Institutional framework (SPCB/CPCB/MOEF) - Supreme Court Judgments in Landmark cases-considerations in setting up of environmental standards

UNIT II

Water (P & CP) Act, 1974: Powers & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III

Air (P & CP) Act, 1981: Powers & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV

Environment (Protection) Act 1986: Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Siting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards.

UNIT V

Other Acts & Management Systems: Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Fundamentals of Environmental Management and ISO 14000 series - principles and elements. The ISO 14001- Environmental management systems standards.

Reference Books:

1. CPCB, "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz "Environmental law and policy in India "Oxford University Press, New Delhi, 2001.
3. Greger I. Megregor, "Environmental law and enforcement", Lewis Publishers, London 1994.
4. Constitution of India [Referred articles from part-III, part-IV and part-IV A]
5. Pares Distn. Environmental Laws in India (Deep, Lated edn.)
6. Handbook of environmental management and technology: Gwendolyn Holmes, Ben Ramnarine Singh, Louis Theodore.
7. The ISO 14000 Handbook: Joseph Cascio.
8. ISO 14004: Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004:1996 (E)).
9. ISO 14001: Environmental management systems: Specification with guidance for use (ISO 14001:1996b(E)) (International organization for standardization-Switzerland)

I-I

**URBAN STORM WATER MANAGEMENT
(Elective-II)**

**L / P / Credits
4 / -- / 3**

UNIT I

General introduction to urbanization and its effect on water cycle – urban hydrological cycle – trends in urbanization – Effect of urbanization on hydrology. Time of concentration – importance of short duration of rainfall and runoff data – methods of estimation of time of concentration for design of urban drainage systems.

UNIT II

Master drainage plans – issues to be concentrated upon – typical content of an urban drainage master plan – interrelation between water resources investigation and urban planning processes – planning objectives – comprehensive planning – use of models in planning.

UNIT III

Basic approaches to urban drainage – runoff quantity and quality – wastewater and storm water reuse – major and minor systems. Elements of drainage systems – open channel – underground drains – appurtenances – pumping – source control.

UNIT IV

Storm water Analysis Calculation of runoff and peak – Design of storm water network systems. Best Management Practices – Detention and retention facilities – Swales-constructed wetlands.

UNIT V

Operation and maintenance of urban drainage system – interaction between storm water management and solid waste management, Various model available for storm water management. Legal aspects

Reading:

1. Geiger, W.F., Marsalek, J. Z., and Rawls, G.J., *Manual on Drainage in Urban Areas, 2 Volumes*, UNESCO, Paris, 1987
2. Hall, M.J., *Urban Hydrology*, Elsevier Applied Science Publishers, 1984
3. Stahre, P., and Urbonas, B., *Storm water Detention for Drainage, water quality and CSO Management*, Prentice Hall, New Jersey, 1990
4. Wanielista, M.P., and Yousef, Y.A., *Storm water Management*, John Wiley and Sons, Inc., New York, 1993

I-I

ENVIRONMENTAL ENGINEERING LABORATORY

L / P / Credits
-- / 4 / 2

Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods -Settling Column Analysis for type II settling, Break point chlorination, determination of Dosage of lime-soda for removal of hardness

Media preparation and inoculation – test for plate count – coliforms – fecal coliforms – E. coli – M.P.N. and M.F. techniques. Bioassay study

Sampling and analysis of ambient air for SPM, SO₂, Oxides of nitrogen - Instrumental methods of analyses for particulates, HC, CO, NO_x, SO₂,

References:

1. Sawyer, C.N. and McCarty, P.L. and Perkin, G.F. “Chemistry for Environmental Engineers”, 4th Edition, McGraw Hill, New Delhi, 1994.
2. De. A.K. “Environmental Chemistry”, New Age International Ltd., New Delhi, 1995.
3. “Standard Methods for the Examination of Water and Wastewater”, 21th Edition, American Public Health Association, Washington. D.C. 2005.

I-II

AIR AND NOISE POLLUTION CONTROL

L / P / Credits

4 / -- / 3

UNIT-I

Introduction: Definition - Sources and classification of Air Pollutants - Photochemical smog - Effects of air pollution on health of Human & Animals, vegetation & materials, air quality, Global effects of air pollution.

UNIT-II

Meteorology and Dispersion of air pollutants: Temperature lapse rates and Stability, Wind velocity and turbulence, Wind Rose, plume behavior, Measurement of meteorological variables. Dispersion of Air pollutants: Theories on modeling of Air pollutants. Gaussian model etc. - Equations for the estimation of pollutant concentrations of emissions - Plume Rise – Equations for estimation. Effective stack height and mixing depths

UNIT-III

Sampling, Analysis and Particulate Pollution Control Methods: Ambient air sampling, HVAS- stack monitoring and sampling methods. Air quality standards. Types of particulate pollution control methods – Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators, design aspects and principle of these air pollution control units.

UNIT-IV

Gaseous pollution control methods and automobile pollution: Gaseous pollutants' sampling and analysis-Types of gaseous pollution control methods – absorption, adsorption and combustion processes. Automobile pollution, sources of pollution, composition of auto exhausts, Control methods. Planning for conducting Air pollution survey

UNIT V

Noise Pollution: Definitions – Significance in general - sources, measurement - effects and control measures, legislations

Reference Books:

1. H. C. Perkins, Air Pollution.
2. Peavy and Rowe, Environmental Engineering, McGraw Hill Publication.
3. N.D. Nevers, Air Pollution Control Engineering, McGraw Hill Publication.
4. M. N. Rao et al. Air Pollution, Tata McGraw Hill Publication.
5. Noel de Nevers, Air Pollution control Engineering, McGraw Hill Publication, New York.
6. Richard W. Boubel et al., Fundamentals of Air Pollution, Academic Press, New York.
7. John H. Seinfeld, Air Pollution: Physical and Chemical Fundamental, McGraw Hill book Co. 1988.
8. Paul N. Cheremisinoff, Richard A. Young, Air Pollution Control and Design Handbook, Part-I, Marcel Dekker Inc., New York 1977).
9. Paul N. Cheremisinoff (ed.), Encyclopedia of Environmental Control Technology, Vol. 2, Air Pollution Control, Guild Publishing Company. (1989).

I-II SOLID AND HAZARDOUS WASTE MANAGEMENT L / P / Credits
4 / -- / 3

UNIT I

Introduction: Definition of solid waste – waste generation-sources and types of solid waste – sampling and characterization – Determination of composition of Municipal Solid Waste – Onsite storage and handling of solid waste – Future changes in waste composition, major legislation, monitoring responsibilities.

UNIT II

Collection and Transport of Solid Waste: Type and methods of waste collection systems, analysis of collection systems-Optimization of collection routes– alternative routes for collection system. Transfer and Transport: Need for transfer operation, transport means and methods, transfer station types and design requirements. Separation and Processing and Transformation of Solid Waste- Waste as a Resource- Disposable Materials, Recycling, Collection, Processing, and Potential for Reuse.

UNIT III

Processing and disposal: unit operations used for separation and processing, Materials Recovery facilities, Source reduction and waste minimization, Metal Separation & Recovery Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators.

UNIT IV

Landfills: Classification, Site selection, design and operation, methods of filling, drainage and leachate collection systems –designated waste landfill remediation, reclamation, environmental closure.

UNIT V

Hazardous Waste Management: Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous wastes regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste - sources, collection, Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration – reuse after treatment.

References:

1. George Tchobanoglous “Integrated Solid Waste Management”, McGraw Hill Publication, 1993.
2. Charles A. Wentz; “Hazardous Waste Management”, McGraw Hill Publication, 1995.

UNIT I

Introduction to EIA: Definition- Concepts, Types-Limitations- components of EIA process- settings – public participation- public hearing - methodologies: background information, interaction matrix methodologies, network methodologies etc, environmental setting various factors, documentation and selection process, environmental indices and indicators for describing affected environment.

UNIT II

EIA notification by Ministry of Environment and Forest (Govt. of India): Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring. Case studies in EIA.

UNIT III

Prediction and assessment of impact for air and noise environment: Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact prediction and assessment, mitigation. Basic information of noise, existing noise levels and standards, prediction of noise levels and assessment of impact, mitigations.

UNIT IV

Prediction and assessment of impact for water and soil environment: Basic information of water quality (Surface water and ground water), water quality standards, identification of impact, prediction of impact and assessment, mitigations. Background information of soil environment, soil and ground water standards, prediction and assessment of impact for ground water and soil, mitigations.

UNIT V

Prediction and assessment of impact on cultural and socioeconomic environment: Basic information on cultural resources, rules and regulations for cultural resources like archaeological, historical structures, Cultural system, prediction and assessment of impact, mitigations. Basic information of socioeconomic environment, description of existing socioeconomic environment, prediction and assessment of impact, mitigation, resettlement and rehabilitation.

Reference Books:

1. Canter R.L., Environmental Impact Assessment, McGraw Hill International Edition, 1997.
2. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.
3. Peter Wathern (Eds.) - 'Environmental Impact Assessment Theory and Practice', Unwin Hyman, London (1988).
4. Guidelines from website of MOEF, GOI and CPCB

I-II

GREEN TECHNOLOGIES

L / P / Credits
4 / -- / 3

UNIT- I

Introduction: Green Technology – definition- Importance – Historical evolution – advantages and disadvantages of green technologies-factors affecting green technologies- Role of Industry, Government and Institutions – Industrial Ecology – role of industrial ecology in green technology

UNIT- II

Cleaner Production (CP): Definition – Importance – Historical evolution -Principles of Cleaner Production–Benefits–Promotion – Barriers –clean development mechanism, reuse, recovery, recycle, raw material substitution-Wealth from waste -Overview of CP Assessment Steps and Skills, Process Flow Diagram, Material Balance, CP Option Generation- Technical and Environmental Feasibility analysis

UNIT- III

Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement, carbon credit, carbon sequestration, carbon trading- Life Cycle Assessment - Elements of LCA – Life Cycle Costing – Eco Labelling.

UNIT -IV

Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Non-conventional energy sources: Solar Energy-solar energy conversion technologies and devices, their principles, working and application.

UNIT- V

Green Fuels – Definition-benefits and challenges – comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts- public policies and market-driven initiatives.

Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in Indian context; tidal and geothermal energy.

REFERENCES:

1. 'Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.
2. 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production' by World Bank Group (1998), World Bank and UNEP, Washington D.C.
3. 'Cleaner Production Audit' by Prasad Modak, C. Visvanathan and Mandar Parasnis (1995), Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok
4. 'Handbook of Organic Waste Conversion' by Bewik M.W.M.
5. 'Energy, The Solar Hydrogen Alternative' by Bokris J.O.
6. 'Non-conventional Energy Sources' by Rai G.D.
7. 'Solar Energy' by Sukhatme S.P.
8. 'Waste Energy Utilization Technology' by Kiang Y. H.

I-II OCCUPATIONAL AND ENVIRONMENTAL HEALTH L / P / Credits
(Elective-III) 4 / -- / 3

UNIT I

Introduction: Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place. Environmental hygiene and sanitation-religious congregations

UNIT II

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

UNIT III

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

UNIT IV

Techniques of Environmental Safety: Methods of effective implementation and review of health & safety policies. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Industry specific EHS issues.

UNIT V

Education and Training: Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

References:

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

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| I-I | ENVIRONMENTAL SYSTEMS ANALYSIS (Elective-III) | L / P / Credits 4 / -- / 3 |
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UNIT I

Systems Engineering – Analysis - Design – synthesis - applications to environmental engineering Systems.

UNIT II

Role of optimization models - Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models.

UNIT III

Formulation of objective functions and constraints for environmental engineering planning and design. Simulation models

UNIT IV

Probabilistic models - Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic - Modern tools - Expert systems - Artificial Neural Networks (ANN): types of ANN and learning algorithms, tasks performed by ANN - Genetic Algorithm - concepts of genetic algorithm, components of genetic algorithm

UNIT V

Environmental Applications & Case studies: Optimization of water distribution network, sewerage systems, solid waste collection systems and routes. Expert systems in water and wastewater treatment

References

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

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| I-I | DISASTER MANAGEMENT (Elective-IV) | L / P / Credits 4 / -- / 3 |
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UNIT-I

Natural Hazards And Disaster Management: Introduction of DM – Inter disciplinary -nature of the subject – Disaster Management cycle – Five priorities for action. Case study of the following disasters: floods, draughts – Earthquakes –cyclones & Tsunamis – Post Tsunami hazards along the Indian coast – landslides.

UNIT-II

Man Made Disaster and their Management: Fire hazards – transport hazard dynamics – post disaster – global warming, bio terrorism -threat in mega cities, rail and air craft's accidents, and emerging infectious diseases & Aids and their management- some case study of the manmade disasters.

UNIT-III

Risk and Vulnerability: Building codes and land use planning – social vulnerability – environmental vulnerability – Macroeconomic management and sustainable development, climate change risk rendition – financial management of disaster – related losses- disaster risk reduction- community focused approach in disaster risk reduction- - Climate change adaptation and human health -Exposure, health hazards and environmental risk-Forest management and disaster risk reduction

UNIT-IV

Role Of Technology In Disaster Managements: Disaster management for infra structures, taxonomy of infra structure – treatment plants and process facilities-electrical substations- roads and bridges-- mitigation programme for earth quakes-flowchart , geospatial information in agriculture drought assessment-multimedia technology in disaster risk management and training- transformable indigenous knowledge in disaster reduction.

UNIT-V:

Education and Community Preparedness: Education in disaster risk reduction-Essentials of school disaster education-Community capacity and disaster resilience-Community based disaster recovery -Community based disaster management and social capital-Designing resilience-building community capacity for action- Impact of disaster on poverty and deprivation-Institutional capacity in disaster management- The Red cross and red crescent movement-Corporate sector involvement in disaster management

M. Tech. (Environmental Engineering and Management)

TEXT BOOKS:

1. 'Disaster Management – Global Challenges and Local Solutions' by Rajib shah & R R Krishnamurthy (2009), Universities press.
2. 'Disaster Science & Management' by Tushar Bhattacharya, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
3. 'Disaster Management – Future Challenges and Opportunities' by Jagbir Singh (2007), I K International Publishing House Pvt. Ltd.

REFERENCE BOOKS:

1. 'Disaster Management' edited by H K Gupta (2003), Universities press.

I-I

**LIFE CYCLE ANALYSIS
(Elective-IV)**

**L / P / Credits
4 / -- / 3**

UNIT I

Introduction, Brief history of Life-cycle inventory analysis-Life Cycle Assessment concepts, Inventory analysis

UNIT II

Procedural framework of Life-cycle inventory: Introduction, define the purpose and scope of inventory

UNIT III

Overview of approaches and methodology, three components, Identifying and setting boundaries for life-cycle stages, issues that apply to all stages, Applications of inventory analysis-General issues in Inventory analysis: Introduction, Using Templates, Data issues, special case boundary issues

UNIT IV

Issues Applicable to specific life cycle stages: Introduction, Raw Material acquisition stage, Manufacturing stage, Use/Reuse/Maintenance stage, Recycle/Waste Management stage.

UNIT V

Case Studies: LCA applications in steel industry, fertilizer industries, mining operations, petroleum refinery-small and medium industries

Reading:

1. Ciambone, D.F., Environmental Life Cycle Analysis, CRC Press, 1997
2. Handbook on Life Cycle Assessment: Operational guide to the ISO standards, Kluwer Academic Publishers, 2004

I-II AIR QUALITY MODELLING AND MANAGEMENT L / P / Credits
(Elective-IV) 4 / -- / 3

1. AIR QUALITY MONITORING: Definition and classification of air pollutants and grouping-Emission sources of pollutants - Source classification Air pollution control regulations and acts Global issues including climate change, acid rain and ozone depletion. Types of air pollutants and their effects-Design of air pollution sampling network-Sampling methodologies for ambient air-Sampling site selection criteria-Ambient air monitoring for particulate matter, gaseous pollutants and volatile organic compounds-Sampling and analysis for SO₂ and NO₂-Analytical methods for rare elements, anions, cations, PAN compounds etc-Online monitoring-State of art analysis for CO, O₃ and WC-QA/QC requirements.

2. AIR POLLUTION METEOROLOGY:

Meteorological aspects of air pollution-Atmospheric and adiabatic lapse rates- Wind speed and direction and preparation of wind rose-Atmospheric stability and stability classification-Mixing height-Inversions-meteorological instruments for air pollution studies-Wind speed, temperature turbulence and upper air measurements- Remote sensing technologies.

3. EMISSION INVENTORY:

Inventory of sources of air pollution-Point, area and line sources of pollution-Emission factors-Emission inventory of industrial sources-Data collection and analysis-Toxic emissions in urban environment-Quantification of emissions from area sources-Non point sources of air pollution and fugitive emissions-Quantification of emissions from mobile sources-Emission inventory modelling.

4. AIR QUALITY MODELLING:

Basics of air quality modelling-Gaussian Dispersion modelling-Different kinds of modelling-Source parameters-meteorological parameters-Dispersion coefficients-Specific applications of air quality modelling-Software application in air quality modelling-Uncertainty and sensitivity analysis-Calibration and validation of models-Performance evaluation of models.

5. AIR QUALITY MANAGEMENT:

Air quality and control strategies –Air pollution control technology for particulate matter- Control technology for gaseous pollutants- assimilation capacity based regional air quality management-National and international scenario.

Reference

1. M.N.Rao , Air Pollution, McGraw Hill Education (India) Pvt Ltd.
2. J. R. Mudakavi, Principles and Practices of Air Pollution Control and Analysis,
3. I.K. International Publishing House Pvt Ltd
4. Pepper Carrington , Modeling Indoor Air Pollution, Imperial
5. Douw G. Steyn , S. T. Rao, Air Pollution Modeling and Its Application, Springer

**I-II COMPUTER APPLICATIONS IN ENVIRONMENTAL
ENGINEERING**

**L / P / Credits
-- / 4 / 2**

1. Design of water distribution system
2. Water quality simulation exercise using WASP, QUAL 2E etc
3. Dispersion of air pollutants using AIRMOD, ISC or equivalent
4. Development of Wind rose using wind rose software

1. Design of water distribution system
 - a. EPANET (Software That Models the Hydraulic and Water Quality Behavior of Water Distribution Piping Systems)
Link : <http://www.epa.gov/nrmrl/wswrd/dw/epanet.html#applications>
2. Water Quality Models
 - a. WASP : <http://www.epa.gov/athens/wwqtsc/html/wasp.html>
 - b. QUAL2K: <http://www.epa.gov/athens/wwqtsc/html/qual2k.html>
 - c. Aquatox: <http://www2.epa.gov/exposure-assessment-models/aquatox>
 - d. EPD-RIV1: <http://www.epa.gov/athens/wwqtsc/html/epd-riv1.html>
3. Dispersion of air pollutants using AIRMOD, ISC
 - a. Link : http://www.epa.gov/scram001/dispersion_alt.htm
4. Development of wind rose wing using wind rose software
 - a. WINDROSE Link : <http://www.enviroware.com/portfolio/windrose-pro/>
 - b. WINDROSE Link <http://www.windrose.gr/index.php/download>