DETAILED SYLLABUS
For
M. Tech. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT), R19

SCHOOL OF RENEWABLE ENERGY AND ENVIRONMENT

INSTITUTE OF SCIENCE AND TECHNOLOGY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - M. Tech. I Semester

I-I	**ADVANCED NUMERICAL METHODS AND APPLIED**	**L / P / Credits**
1.1	**STATISTICS**	**3 / -- / 3**

Course Objectives: This course is aimed at enabling the student to

1. To help the students learn mathematical skills and techniques that is essential for Environmental engineering course.
2. To impart knowledge on probability distribution and reliability statistical methods.

Course Outcomes: At the end of the course, student will be able to

1. Evaluate single and multiple integrals using numerical integration (K5)
2. Solve ordinary differential equations using numerical methods (K3)
3. Solve boundary value problems using finite difference schemes (K3)
4. Apply implicit and explicit methods to solve partial differential equations (K3)
5. Analyze the problems using correlation and regression methods (K4)
6. Explain Joint probability distributions and reliability applications (K5)

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.

Unit-II: Numerical solutions of 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, Multi step methods, Finite Difference Technique for Boundary Value Problems (BVP), derivative boundary conditions, convergence and stability of finite difference schemes.

Unit-III: Numerical solutions of Partial Differential Equations

Finite Difference Approximations.

Finite difference methods – Elliptic equations: Laplace equation, Solution Technique, Boundary Conditions, The Control-Volume Approach - Parabolic Equations: The Heat-Conduction Equation, Explicit Methods, A Simple Implicit Method, The Crank-Nicolson Method, Parabolic Equations in Two Spatial Dimensions.

Unit-IV: Regression and Correlation

Regression and correlation analysis – Methods of least squares, Curve fitting, Curvilinear Regression, Non linear curves, Correlation coefficient, Correlation of grouped bi-variate data, Coefficient of determination Multiple Regression, one way and two way analysis of variance for regression.

Unit-V: Joint Distribution and Reliability Theory

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

Reliability applications: Failure rate – Failure Laws of Exponential, Normal, Weibull models, Reliability of a component - System reliability connected with parallel and series components.

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 Year - M. Tech. I Semester

I-I 1.2	**Unit Operations and Processes in Water and Wastewater Treatment**	**L / P / Credits** 3 / -- / 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, Gas transfer, freezing

UNIT II

Chemical Unit Processes: Neutralization – Coagulation – 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, 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. "Rural Municipal and Industrial water management", KVSG Murali krishna; Reem publications, New Delhi,2015.
2. ." Wastewater Engineering, Treatment and Reuse" - Metcalf & Eddy - Tata McGraw Hill, 4th Edition New Delhi, 2003.

1 "Biological Processes Design for wastewaters" - Benefield, L.D. and Randall C.W., Prentice -Hall, Inc.Eaglewood Cliffs, 1982.

2 "Biological wastewater treatment: Theory and Applications*"* - Grady Jr. C.P.L and Lin H.C., Marcel Dekker, Inc, New York, 1980.

I Year - M. Tech. I Semester

I-I	**INDUSTRIAL WATER AND WASTEWATER MANAGEMENT**	**L / P / Credits**
1.3(a)	**ELECTIVE - I**	**3 / -- / 3**

UNIT I

Industrial Water: Quality and quantity requirements of boiler and cooling waters – Quality and quantity requirements of process water for various industries - Quality and quantity requirements for irrigation, construction

UNIT II

Industrial Waste water: Sources and types of industrial wastewater – Nature and Origin of Pollutants - Toxicity of industrial effluents - Industrial wastewater monitoring - Generation rates, characterization, variables and sampling.–reduction techniques – Strength & volume Reduction - Material balance - Evaluation of Pollution prevention options - Waste minimization Circles.

UNIT III

Wastewater Treatment, Reuse and Residue 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 – Residues of industrial wastewater treatment – Quantification and characteristics of Sludge – Management of RO rejects.

UNIT-IV

Treatment of Specific Industrial wastewaters (part-1): Manufacturing process and sources of effluent from the process of industries like fertilizer, pulp and paper, sugar, distillery, tannery, Textiles, food processing, dairy and Pharmaceuticals - Industrial manufacturing process description, wastewater characteristics.

UNIT-V

Treatment of Specific Industrial wastewaters (part-2): Manufacturing process and sources of effluent from the process of industries like: Steel, Petroleum Refineries, Atomic Energy Plants, Metal finishing, Mineral Processing Industries and Mining activities - Industrial manufacturing process description, wastewater characteristics.

Reference Books:

1. ”Waste water treatment “- M.N.Rao & A.K. Datta.
2. ”Industrial Water and Waste Water Management” KVSG Murali Krishna, Paramount Publishers, Vishakhapatnam, 2017.
3. “Wastewater Treatment for Pollution Control” - Arceivala S.J and Asolekar -McGraw Hill, 1998.
4. “Industrial waste treatment Handbook “- Frank Woodard, Butterworth Heinemann.
5. “Industrial waste treatment - contemporary practice and vision for the future” - Nelson Leonard Nemerow, Elsevier, Singapore, 2007.
6. “Industrial Wastewater Management Hand Book” - Hardam S. Azad, (ED), 1988.
7. Indian standards: IS: 2490 (1963), IS: 3306 (1065).
8. ”Pollution Prevention: - Fundamentals and Practice” - Paul L. Bishop, Mc-Graw Hill International, Boston, 2000.

I Year - M. Tech. I Semester

I-I	**ENVIRONMENTAL HYDROLOGY AND HYDRAULICS**	**L / P / Credits**
1.3(b)	**ELECTIVE - I**	**3 / -- / 3**

Unit I

Hydrology: Statistical analysis of Hydrological Data - Rainfall and Runoff estimation, Intensity duration frequency Curves, Storage capacity of reservoirs, Draft storage with different risks.

Unit II

Environmental Hydraulics of groundwater flow: Non–equilibrium flow, Yield estimations, Interferences - Infiltration galleries, ground water recharge- Pollutant transport phenomenon in groundwater – diffusion – dispersion – advection – adsorption - conservative and non-conservative pollutants.

Unit III

Environmental Hydraulics of Surface Water flow: Governing Equations for flow and transport in surface waters - chemical and biological process models - simplified models for lakes, streams, and estuaries.

Unit IV

Transportation and Distribution of water Pumping of Water: Design and selection of economical diameter of pumping main – open channel flow – design of open channel flow sections- Distribution of Water - Pressure and capacity requirements of distribution system, Analysis of networks.

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 Year - M. Tech. I Semester

I-I 1.3(c)	**REMOTE SENSING & GIS APPLICATONS IN ENVIRONMENTAL ENGINEERING ELECTIVE - I**	**L / P / Credits 3 / -- / 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 Year - M. Tech. I Semester

I-I	**ENVIRONMENTAL CHEMISTRY AND MICROBILOGY**	**L / P / Credits**
1.4(a)	**ELECTIVE - II**	**3 / -- / 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 Year - M. Tech. I Semester

I-I	**URBAN STORM WATER MANAGEMENT**	**L / P / Credits**
1.4(b)	**(ELECTIVE-II)**	**3 / -- / 3**

UNIT I

Urban hydrology: General introduction to urbanization, trends in urbanization, Effect of urbanization on hydrology, effect on hydrological cycle – 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: Typical content of an urban drainage master plan, environmental issues–water resources management: objectives -comprehensive planning- interrelation between water resources investigation and urban planning processes – use of models in planning.

UNIT III

Storm water Management: Calculation of runoff and peak discharges – Design of storm water network systems - storm water reuse – major and minor systems- Source control and reuse of wastewater - Best Management Practices – Detention and retention facilities – Swales-constructed wetlands.

UNIT IV

Urban drainage systems: Elements of drainage systems– open channel – underground drains – appurtenances – pumping – Design of Urban drainage systems.

UNIT V

Operation and maintenance of urban drainage system: Interaction between storm water management and solid waste management, models available for storm water management. Software applications in the design of urban drainage system.- Case studies on urban inundation .

Reading:

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

I Year - M. Tech. I Semester

I-I	**ENVIRONMENTAL LEGISLATIONS AND MANAGEMENT SYSTEMS (Elective-II)**	**L / P / Credits**
1.4(c)		**3 / -- / 3**

UNIT I

Global Environmental Policies: UNO and Environmental Protection – EPA Guidelines for environmental protection - International multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration etc –Government of India environmental policies – Ministry of Environment, Forest and Climate Change -Institutional framework (SPCB/CPCB/NGT) –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 – 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 – 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: Provisions of Act – delegation of powers – Role of Central Government - EIA Notification – Siting of Industries – Coastal Zone Regulations - Responsibilities of local bodies –Legislations on Solid Waste Management (MSW, Biomedical, Plastic, e-waste, Hazardous waste) - Indian Forest Act.

UNIT V

Legislative Management Systems: Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - ISO 14000 - ISO 14001- Environmental management systems - CPCB/ICMR/ICAR standards. - Scheme of Consent for establishment, Consent for operation - SEAC Environmental Clearance.

Reference Books:

1. "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Serie – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. "Environmental law and policy in India" - Shyam Divan and Armin Roseneranz - Oxford University Press, New Delhi, 2001.
3. "Environmental law and enforcement" - Greger I. Megregor - Lewis Publishers,London1994.
4. Constitution of India [Referred articles from part-III, part-IV and part-IV A]
5. Pares Distn. Environmental Laws in India (Deep, Latededn.)
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 Year - M. Tech. I Semester

I-I	RESEARCH METHODOLOGY and IPR (Common with other specializations)	L / P / Credits
1.5		2 / --- / 2

I Year - M. Tech. I Semester

I-I 1.6	**ENVIRONMENTAL QUALITY MONITORING LABORATORY - I**	**L / P / Credits -- / 4 / 2**

1. To determine pH, EC and Chloride in water (RO System) and soil sample.
2. To determine Total Hardness and temporary Hardness – Ca and Mg of the given water sample.
3. To determine the optimum dosage of coagulants and coagulant aids for the given water sample .
4. Analysis of solids content of water
   (i) Total Solids
   (ii) Suspended Solids
   (iii) Total Dissolved Solids
   (iv) Volatile Solids of a given water sample
5. To determine Residual chlorine and Chlorine demand of a given water sample.
6. To determine the Oil and Grease in sewage sample.
7. Sampling and laboratory analysis of solid waste – Percent Composition , Moisture Content , Density , Calorific Value, C/N Ratio , N, P, K , Total organic content , Boron.
8. Determination of nitrates concentration by using UV- Spectrophotometer

References:

1. ”Environmental engineering lab manual”, KVSG Murali Krishna ,Reem Publications , New Delhi,2019.
2. “Chemistry for Environmental Engineers” - Sawyer, C.N. and McCarty, P.L. and Perkin, G.F. 4th Edition, McGraw Hill, New Delhi, 1994.
3. “Environmental Chemistry” - De. A.K. New Age International Ltd., New Delhi, 1995.
4. “Standard Methods for the Examination of Water and Wastewater”, 21th Edition, American Public Health Association, Washington. D.C. 2005.

I Year - M. Tech. I Semester

I-I	**ENVIRONMENTAL ENGINEERING AND MICROBIOLOGY LABORATORY - II**	**L / P / Credits**
1.7		**-- / 4 / 2**

1) Ambient Air Quality Monitoring: Concentration of particulate matter present in air (PM_{10} & $PM_{2.5}$), SO_2 and NOx by using High Volume Air Sampler.
2) Stack Monitoring: Concentration of particulate matter present in air (PM_{10} & $PM_{2.5}$), SO_2 and NOx and other parameters.
3) To determine the dissolved oxygen and BOD present in a given sample.
4) To determine the chemical oxygen demand present in waste water sample
5) Type- II settling of particle sedimentation
6) Break point chlorination test
7) Media preparation , Inoculation and Plate count test.
8) Most Probable Number (MPN) test
9) Membrane filtration techniques.
10) Noise Isopleths in Institution or Industry.
11) TCLP – Leachate from Landfills.
12) Micrometeorology –Wind Direction , Wind speed , Humidity Temperature , Rainfall.
13) Automobile emission test.

I Year - M. Tech. II Semester

I-II		**L / P / Credits**
2.1	**AIR AND NOISE POLLUTION CONTROL**	**3 / -- / 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 standards, 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: Gaussian Dispersion model - Equations for the estimation of pollutant concentrations of emissions - Plume Rise –Effective stack height and mixing depths.

UNIT-III

Sampling, Analysis and Particulate Pollution Control Methods: Ambient air quality monitoring -High volume sampler- stack monitoring train and stack monitoring - Principles and design aspects of different types of particulate pollution control equipment– Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators,

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.

UNIT V

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

Reference Books:

1. Air Pollution by M. N. Rao, Tata McGraw Hill Publication.
2. "Air pollution and control by KVSG Murali Krishna , Laxmi Publications, New Delhi, 2016.
3. Air Pollution by H. C. Perkins.
4. Environmental Engineering by Peavy and Rowe, McGraw Hill Publication.
5. Air Pollution Control Engineering by N.D. Nevers, McGraw Hill Publication.
6. Air Pollution control engineering by Noel de Nevers, McGraw Hill Publication, New York.
7. Fundamentals of Air Pollution by Richard W. Boubel et al, Academic Press, New York.
8. Air Pollution: Physical and Chemical Fundamentals by John H. Seinfeld, McGraw Hill book Co. 1988.

I Year - M. Tech. II Semester

I-II 2.2	SOLID AND HAZARDOUS WASTE MANAGEMENT	L / P / Credits 3 / -- / 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 Techobanoglous “Integrated Solid Waste Management”, McGraw Hill Publication, 1993.
2. Charles A. Wentz; “”Hazardous Waste Management”, McGraw Hill Publication, 1995.

I Year - M. Tech. II Semester

I-II	**ENVIRONMENTAL IMPACT ASSESSMENT**	**L / P / Credits**
2.3(a)	**ELECTIVE III**	**3 / -- / 3**

UNIT I

EIA– Components and Methods: Definition- Concepts, types, Limitations- components of EIA process-environmental setting various factors, documentation and selection process, environmental indices and indicators for describing affected environment. -methodologies**:** background information, Adhoc, Checklist, interaction matrix and network methodologies

UNIT II

EIA notification by Ministry of Environment and Forest (Govt. of India): Provisions in the EIA notification, Public participation- Public hearing, 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, Environmental audit.

UNIT III

Prediction and assessment of impact on 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, mitigation.

UNIT IV

Prediction and assessment of impact on water and soil environment: Basic information of water quality (Surface water and groundwater), water quality standards, identification of impact, prediction of impact and assessment, mitigation. Background information of soil environment, soil characteristics, prediction and assessment of impact on soil and mitigation.

UNIT V

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

Text Books:

1 Environmental Impact Methodologies – Y Anjaneyulu ValliManickam.

Reference Books:

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

I Year - M. Tech. II Semester

I-II	**GREEN TECHNOLOGIES**	**L / P / Credits**
2.3(b)	**ELECTIVE III**	**3 / -- / 3**

UNIT- I

Introductionto 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

New and Renewable Energy: Conventional energy resources - Environmental future needs of energy and availability. Non-conventional energy sources: Solar Energy-solar energy conversion technologies and devices, their principles, working and application, Wind Energy – production Technologies, Tidal and geothermal energy.

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 , conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in Indian context.

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 Year - M. Tech. II Semester

I-II	**ENVIRONMENTAL SYSTEMS ANALYSIS**	**L / P / Credits**
2.3(c)	**ELECTIVE-III**	**3 / -- / 3**

UNIT I

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

UNIT II

Optimization models: Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models. Formulation of objective functions and constraints for environmental engineering planning and design. Simulation models

UNIT III

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

UNIT IV

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.

I Year - M. Tech. II Semester

I-II	**DISASTER MANAGEMENT**	**L / P / Credits**
2.4(a)	**ELECTIVE-IV**	**3 / -- / 3**

UNIT-I: Types of Disasters:
Disaster - concept and definitions of disaster, causes of disasters, types – natural disasters – floods, droughts, cyclones, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold wave, global warming, sea level rise, ozone depletion. Man-made disasters: Sociological – political – industrial and human disasters.

UNIT-II: Risk Assessment and Analysis
Concept and elements of Hazards, Risks and Vulnerability – Policies of Disaster Management, Identification of Crisis Situation, strategic developments, roles and responsibilities of recovery team, importance of team building in disaster management

UNIT-III: Disaster Preparedness:
Prevention and Preparedness – Plan, Action and Accountability, Concept and Nature of Disaster Preparedness, Plan of Disaster Preparedness for People with Special Needs/Vulnerable Groups, with Relevance to Housing, Infrastructure and Livestock, Community Based Disaster Preparedness Plan, Role of Information technology, Education, Communication and training. Medical and health preparedness plan.

UNIT-IV: Disaster Damage Assessment and Response:
Needs and Damage Assessment– Control process and measurement – modern and traditional methods of response, Disaster Response Plan – roles of response teams and forces. Epidemiological Study of Disasters - Medical and Health Response to Different Disasters - Role of Information and Communication Technology in Health Response

UNIT-V: Disaster Mitigation and Recovery:
Disaster Mitigation – meaning and concept – structural mitigation and non-structural mitigation – mitigation strategies and emerging trends. Reconstruction and rehabilitation for development, Medium and long-term recovery aspects, Participative Rehabilitation Process: Community involvement and development of infrastructure.

TEXT BOOKS:
1. 'Disaster Management – Global Challenges and Local Solutions' by Rajib shah & R RKrishnamurthy (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 Year - M. Tech. II Semester

I-II	**OCCUPATIONAL AND ENVIRONMENTAL HEALTH**	**L / P / Credits**
2.4(b)	**ELECTIVE-IV**	**3 / -- / 3**

UNIT I

Environmental Health and Safety: Need for developing Environmental Health and Safety systems in work places. Ergonomics and work place - Environmental hygiene and sanitation - Principles of Environmental Health and Safety policy, awareness of Safety, International initiatives. Regulations and Codes of Practice in India.

UNIT II

Occupational Health and Hygiene: Definition – Health hazards. Exposure pathways and Effects on humans. Human responses to hazardous and toxic substances. Control methods and reduction strategies for occupational health risks like noise, radiation and excessive stress. OH&S policy, OHSAS 18001:2007

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. Role of personal protective equipment and the selection criteria. 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

Environmental Safety Management: Objectives of Safety management, Safety Act and provisions for workers welfare. 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

I Year - M. Tech. II Semester

I-II 2.4(c)	**AIR QUALITY MODELLING AND MANAGEMENT** ELECTIVE-IV	L / P / Credits 3 / -- / 3

1. AIR QUALITY MONITORING:
Definition of Air Pollution Classification, sources and grouping of air pollutants, 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 SO_2 and NO_2-Analytical methods for rare elements, anions, cations, PAN compounds etc-Online monitoring-State of art analysis for CO,O_3 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-Inversions-Mixing Height -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 arc 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. KVSG Murali Krishna , Air pollution and control, laxmi publications, New Delhi, 2016.
3. J. R. Mudakavi, Principles and Practices of Air Pollution Control and Analysis,
4. I.K. International Publishing House Pvt Ltd
5. Pepper Carrington ,Modeling Indoor Air Pollution, Imperial
6. Douw G. Steyn , S. T. Rao,Air Pollution Modeling and Its Application, Springer.

I Year - M. Tech. II Semester

I-II	SOFTWARE APPLICATIONS IN ENVIRONMENTAL ENGINEERING LABORATORY -III	L / P / Credits
2.5		-- / 4 / 2

1. Hydraulic performance of water distribution system (Tank /Pump/Reservoir) by using EPANET software
2. Determination of water quality in a Pond/ Lake/River by using AQUATOX Software
3. Plotting of noise isopleths (Contour) using TERAPLOT Software
4. Water quality parameter simulation exercise by QUAL2K software
5. Dispersion of air pollutants using AIRMOD software
6. Industrial Noise modeling by using Inoise Software
7. Hazardous Chemical Dispersion by using cameosuit (ALOHA) software
8. Water parameters simulation by using VISUAL MODFLOW Software
9. Water flow and solute transport by using HYDRUS – 1D software
10. Strom water management by using SWMM software.
11. Life cycle assessment by Simapro/Gabi/Open lca software.
12. Environmental data and monitoring and planning by ArcMap 10 (GIS) software , Arc SWAT, QGIS.

References:

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

I Year - M. Tech. II Semester

I-II	ENVIRONMENTAL PROCESS DESIGN AND DRAWING LABORATORY - IV	L / P / Credits
2.6		-- / 4 / 2

1. Review of the Principles of design and drawing of water supply and treatment units from source to distribution system.
2. Review of Principles of design and drawing of wastewater treatment units.
3. Detailed design and drawings of various types of intake structures, conduits, pipes, ground level reservoirs and elevated service reservoirs.
4. Preparation of drawings for various house plumbing fixtures.
5. Design and drawings of various types of distribution systems and various methods of analysis of distribution networks
6. Development of Wind Rose, Pollution Rose using MS-EXCEL , HYDROGOMON software.
7. Design and drawing of Garland drains, Rain water harvesting structures.
8. Neutralization and equalization tank for effluents from chemical and biological research labs.

Text Books:

1. Public Health Engineering By Duggal.
2. Water Supply and Sanitary Engineering By Birdi.
3. Water Supply and Sanitary Engineering By Hussain.

I Year - M. Tech. II Semester

I-II	**MINI PROJECT WITH SEMINAR**	**L / P / Credits**
2.7		**-- / 4 / 2**

1. Visiting an Industry and study of statutory Compliance Report of an Industry as prescribed by PCB.
2. Development of Green campus eco- scores for a given institution/ Communities.
3. Visit to Waste to Energy Plants and preparation of report.
4. Visit to Bio – medical waste treatment plants and preparation of report.
5. Visit to Engineered Landfills and Sludge digestion plant and preparation of report.
6. Study of Slum developmental programmes
7. Study of environmental guidelines of NBC 2016 for Apartments/Gated communities/Malls.
8. Study an Eco tourism project and suggest improvements.
9. Bio diversity in an Institution, Industry.
10. New and innovative ideas leading to a project on the concept “WEALTH FROM WASTE”.

(Student shall submit a report in 10 to 20 pages on any one of the above cited topics and attend the VIVA – VOCE examination with a power point presentation.)

II Year - M. Tech. III Semester

II-III		**L / P / Credits**
3.1(a)	**LIFE CYCLE ANALYSIS**	**3 / -- / 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. Ciambrone, 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

II Year - M. Tech. III Semester

II-III		**L / P / Credits**
3.1(b)	**BIOREMEDIATION**	**3 / -- / 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 Biobenificiation – 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.

Text Books

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

II Year - M. Tech. III Semester

II-III	**CLIMATE CHANGE AND GLOBAL ENVIRONMENTAL ISSUES**	**L / P / Credits**
3.1(c)		**3 / -- / 3**

UNIT I: EARTH'S CLIMATE SYSTEM

Introduction- the Earth's Climate – Climate Zones - Wind patterns - Cloud Formation and Monsoon Rains – Storms and Hurricanes – Global Ocean currents – El Nino, La Nino and its Effects - Solar Radiation.

UNIT II: CLIMATE CHANGE – CAUSES AND EFFECTS

Observation of Climate Change – Changes in patterns of temperature, precipitation - Drivers of Climate Change - Patterns of Large Scale Variability - Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society - Evidences of Changes in Climate and Environment – on a Global Scale and in India.

UNIT III: CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategies and Mitigation measures in various sectors: Water, Agriculture, Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Introduction to Climate change modelling

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UNIT IV: GLOBAL ENVIRONMENTAL CHALLENGES

The Earth's Natural Green House Effect – Green House Gases and Global Warming –Heat Islands - Carbon Cycle - Carbon sequestration – Carbon capture and storage (CCS) –Carbon Credits –Forest Fires – Rise in sea level – Ozone layer depletion – Acid rains.

UNIT V: LEGISLATIONS AND CASE STUDIES

UNFCC – IPCC –Montreal Protocol –Kyoto Protocol – Government of India Policies - International and Regional cooperation – Case studies on climate change and global environmental issues.

Reading:

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

II Year - M. Tech. III Semester

II-III	**OPEN ELECTIVE**	**L / P / Credits**
3.2	**(Offered to students of other branches)**	**3 / -- / 3**

Subjects:

1. **Air and noise pollution control**
2. **Environmental Impact assessment**
3. **Disaster Management**