Vision and Mission of the University

Vision

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

Mission

1. Design an Industry relevant curriculum from time to time with a Global perspective
2. Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism
3. Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society
4. Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices
5. International Collaborations for student outreach
6. Facilitating international students to study in JNTUK to infuse cross culture learning practices.

Vision and Mission of the Institute

Vision and Mission of the Department

Programme Education Objectives (PEOs) of the M. Tech

Mapping of Mission statements to PEOs

Programme Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4:

PO5:

PO6:

Note: Program may add up to three additional POs

Mapping of Programme Outcomes to PEOs

Mapping of Programme Outcomes to GAs

COURSE STRUCTURE
For
R25 M. Tech.
(EM/EEM)
Common to (ENVIRONMENTAL ENGINEERING & ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, ANDHRA PRADESH, INDIA

R25 M.TECH ENVIRONMENTAL ENGINEERING & MANAGEMENT

Programme Structure

R25 M. Tech (EEM) Structure

M. Tech I – Semester

S. No.	Course Title	L	T	P	C
1	Environmental Chemistry and Microbiology	3	1	0	4
2	Unit Operations and Processes in Water and Wastewater Treatment	3	1	0	4
3	Environmental Impact Assessment	3	1	0	4
4	Program Elective – I	3	0	0	3
5	Program Elective – II	3	0	0	3
6	Environmental Chemistry and Microbiology Lab - I	0	1	2	2
7	Software Applications in Environmental Engineering Lab - II	0	1	2	2
8	Seminar-I	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

List of Professional Elective Courses in I Semester (Electives – I & II)

S. No.	Course Title
1	Remote Sensing and GIS Applications in Environmental Engineering
2	Environmental Hydrology and Hydraulics
3	Climate change and global environmental issues
4	Life Cycle Analysis
5	Urban Strom water Management
6	Environmental Legislations and Management Systems
7	
8	

@ Minimum 2/3 themes per elective

M.Tech II – Semester

S. No.	Course Title	L	T	P	C
1	Air and Noise Pollution Control	3	1	0	4
2	Solid and Hazardous Waste Management	3	1	0	4
3	Industrial Water and Wastewater Management	3	1	0	4
4	Program Elective – III	3	0	0	3
5	Program Elective - IV	3	0	0	3
6	Environmental Engineering Laboratory – III	0	1	2	2
7	Environmental Process Design and Drawing Laboratory –IV)	0	1	2	2
8	Seminar – II	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

*During the summer break, students need to pursue Summer Internship/ Industrial Training, it will be evaluated in the III Sem.

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Title
1	Advanced Numerical Methods and Applied Statistics
2	Green Technologies
3	Environmental System Analysis
4	Disaster Management
5	**Safety, Health and Environment**
6	Air Quality Modelling and Management
7	
8	

@ Minimum 2/3 themes per elective

M.Tech III Semester

S. No.	Course Title	L	T	P	C
1	Research Methodology and IPR / *Swayam 12 week MOOC course – RM&IPR*	3	0	0	3
2	Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3	Comprehensive Viva#	-	-	-	2
4	Dissertation Part – A$	-	-	20	10
	TOTAL	**3**	**-**	**20**	**18**

* Student attended during summer / year break and assessment will be done in 3rd Sem.
# Comprehensive viva can be conducted courses completed upto second sem.
$ Dissertation – Part A, internal assessment

M. Tech. IV Semester

S. No.	Course Title	L	T	P	C
1	Dissertation Part – B%	-	-	32	16
	TOTAL	**-**	**-**	**32**	**16**

% External Assessment

I Semester	ENVIRONMENTAL CHEMISTRY AND MICROBILOGY	L	T	P	C
		3	1	0	4

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.

Online Learning Resources: (Pls include hyperlinks related to NPTEL/Vlabs/IITB Spoken Tutorial etc.,)

Note: You are requested to use Calibri font with 11 size, for the content.

I Semester	UNIT OPERATIONS AND PROCESSES IN WATER AND WASTE WATER TREATMENT	L	T	P	C
		3	1	0	4

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**.**

UNIT II

Physico-Chemical Unit Operations: Theory, functions and Design criteria**:** Screening, Sedimentation, Coagulation, Flocculation, Filtration, Disinfection; Application of Membrane Processes - Micro-filtration, Ultrafiltration, Nano-filtration, Reverse Osmosis - Electro-dialysis,

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 aerobic treatment processes: Activated Sludge Process, Trickling Filters, Aerated Lagoons, rotating biological Contactors, sequential batch reactors, Stabilization ponds, Oxidation ditch

UNIT V

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

Reference Books

1. Unit Operations and Processes in Environmental Engineering by Paul Richards and Tom Reynolds, Pws Series in Engineering, 1995.
2. “Wastewater Engineering, Treatment and Reuse” - Metcalf & Eddy - Tata McGraw Hill, 4th Edition New Delhi, 2003.
3. “Biological Processes Design for wastewaters” - Benefield, L.D. and Randall C.W., Prentice -Hall, Inc. Eaglewood Cliffs, 1982.

I Semester	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	1	0	4

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 and Valli Manickam.

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).

I Semester	REMOTE SENSING & GIS APPLICATONS IN ENVIRONMENTAL ENGINEERING PROFESSIONAL ELECTIVE - I	L	T	P	C
		3	0	0	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 Semester	ENVIRONMENTAL HYDROLOGY AND HYDRAULICS PROFESSIONAL ELECTIVE - I	L	T	P	C
		3	0	0	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 Semester	CLIMATE CHANGE AND GLOBAL ENVIRONMENTAL ISSUES	L	T	P	C
		3	0	0	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.

REFERENCE BOOKS:

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.

I Semester	LIFE CYCLE ANALYSIS PROFESSIONAL ELECTIVE - II	L	T	P	C
		3	0	0	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. Camborne, 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 Semester	URBAN STORM WATER MANAGEMENT (PROFESSIONAL ELECTIVE -II)	L	T	P	C
		3	0	0	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 Youssef, Y.A., John Wiley and Sons, Inc., New York, 1993

I Semester	ENVIRONMENTAL LEGISLATIONS AND MANAGEMENT SYSTEMS (PROFESSIONAL ELECTIVE -II)	L	T	P	C
		3	0	0	3

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 – Sitting 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 Rosencrantz "Environmental law and policy in India "Oxford University Press, New Delhi, 2001.
3. Greger I. Macgregor, "Environmental law and enforcement", 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, 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 Semester	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY LABORATORY - I	L	T	P	C
		0	1	2	2

I Year - M. Tech. I Semester

1) Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods
2) Settling Column Analysis for type II settling
3) Break point chlorination
4) Determination of Dosage of lime-soda for removal of hardness
5) Media preparation and inoculation and Test for plate count
6) Coliforms – fecal coliforms – E. Coli
7) M.P.N. and M.F. techniques.
8) Determination of nitrates concentration by using UV- Spectrophotometer
9) To determine the dissolved oxygen and BOD present in a given sample.
10) To determine the chemical oxygen demand present in waste water sample

I Semester	SOFTWARE APPLICATIONS IN ENVIRONMENTAL ENGINEERING LABORATORY -II	L	T	P	C
		0	1	2	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.
13. Development of Wind Rose, Pollution Rose using MS-EXCEL, HYDROGOMON software.

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

II Semester	AIR AND NOISE POLLUTION CONTROL	L	T	P	C
		3	1	0	4

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.

II Semester	SOLID AND HAZARDOUS WASTE MANAGEMENT	L	T	P	C
		3	1	0	4

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.

II Semester	INDUSTRIAL WATER AND WASTEWATER MANAGEMENT	L	T	P	C
		3	1	0	4

UNIT 1

Characteristics of wastewater: Sources and types of industrial wastewater - Comparison between municipal and industrial wastewater characteristics - characteristics of treatment plant effluents,

Physical Unit Operations: Theory, functions and design process for the Grit removal, Equalization, Flotation, Aeration, Gas transfer, proportioning.

UNIT 2

Principles of Industrial waste Treatment: Waste reduction, pretreatment of wastes, collection and segregation of wastes, reduction in volume and strength - Waste minimization – Common Effluent treatment Plants – Zero effluent discharge systems - Industrial reuse of treated effluent

Chemical Unit Processes: Neutralization – Chemical oxidation and precipitation - Heavy metal removal - Oil separation – Adsorption - Photo catalysis – Wet Air Oxidation –Electrochemical Processes (precipitation and coagulation) - Electrodialysis – Removal of colour - Control of odour, Control of volatile organic compounds.

UNIT 3

Principles of biological waste treatment: Biodegradability assessment - Treatment systems in continuous and semi-continuous reactors– selection of process - Nutrient removal - Hybrid reactors for the treatment of wastewater: IFAS, MBR, Expanded / fluidized bed bio reactors, UASB - Nutrient removal; Aerobic and anaerobic sludge digestion - Disposal into water bodies and on to the land - self-purification capacity of streams

UNIT-IV

Treatment of Specific Industrial wastewaters (Part-1): Manufacturing process, sources of effluent from the process, characteristics and treatment flow of industries like pulp and paper, sugar, distillery, tannery, food processing, dairy, fertilizer, textiles.

UNIT-V

Treatment of Specific Industrial wastewaters (part-2): Manufacturing process, sources of effluent from the process, characteristics and treatment flow of industries like Steel, Petroleum

Refineries, Electroplating /Metal finishing, Mineral Processing Industries, Mining activities, Petrochemicals, and Pharmaceuticals

Text Books

1. Wastewater Treatment by M.N. Rao and A. K. Datta. Oxford & IBH Publishing Co. New Delhi.
2. Industrial Water Pollution Control by W. Wesley Eckenfelder, Jr.; McGraw-Hill Publishing co., New Delhi
3. "Industrial Water and Waste Water Management" KVSG Murali Krishna, Paramount Publishers, Vishakhapatnam, 2017.

Reference Books

1. Industrial Wastewater Treatment by Patwardhan, A.D. PHI Learning Pvt. Ltd.
2. A Comprehensive Book on Industrial Waste and Management by Dr. H.S. Bhatia. Misha Books
3. Industrial Waste Treatment Handbook by Frank Woodard. Butterworth–Heinemann.

II Semester	ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS (PROFESSIONAL ELECTIVE -I)	L	T	P	C
		3	0	0	3

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.

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.

II Semester	GREEN TECHNOLOGIES PROFESSIONAL ELECTIVE I	L	T	P	C
		3	0	0	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.

II Semester	ENVIRONMENTAL SYSTEMS ANALYSIS PROFESSIONAL ELECTIVE I	L	T	P	C
		3	0	0	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.

II Semester	DISASTER MANAGEMENT PROFESSIONAL ELECTIVE-II	L	T	P	C
		3	0	0	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 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.

II Semester	SAFETY, HEALTH AND ENVIRONMENT PROFESSIONAL ELECTIVE-II	L	T	P	C
		3	0	0	3

Course Objectives

- Teach the need for developing Environment, Health and Safety systems in work places
- Impart the fundamental knowledge on the occupational health and industrial hygiene and the Environmental Safety Management Principles & practices
- Get acquainted with the principles of ergonomics.
- Make the students understand the Workplace Safety and Safety Systems
- Familiarize the quality management systems in health and safety management and need for education and training

Course Outcomes

After completion of the course, the student will be able to

- Understand the concept of EHS and their importance in the work place environment
- Gain a fundamental understanding of the workplace safety and safety systems and knowledge of the safety technologies
- Identify the hierarchy of control measures for occupational health risks and the role of personal protective equipment and the selection criteria
- Understand the Workplace Safety and Safety Systems along with the features of the satisfactory design of work premises HVAC systems
- Comprehend the information from the quality manuals, safety policies & written risk assessments and health and safety records and other documentation in an organization.

Syllabus

Unit I: Introduction to Occupational Health and Hygiene: Definition of Occupational Health and hygiene - Environmental Safety Management - Principles practices- Need for developing Environment, Health and Safety systems in work places. Regulations and Codes of Practice. Role of trade union safety representatives - International initiatives. Ergonomics and work place. Medical surveillance for control of occupational diseases and health records.

Unit II: Industrial Hygiene: Definition of Industrial 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. Control Measures - Hierarchy of control measures for occupational health risks- Evaluation and control of basic hazards; Role of personal protective equipment and the selection criteria. Concept of threshold, limit values. 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 organization 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.

Text Books

1. R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
4. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005

Reference Books

1. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.
3. Heinrich H.W, Industrial Accident Prevention, McGraw Hill Company, NewYork,1980.

II Semester	AIR QUALITY MODELLING AND MANAGEMENT PROFESSIONAL ELECTIVE-II	L	T	P	C
		3	0	0	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.

II Semester	ENVIRONMENTAL ENGINEERING LABORATORY - III	L	T	P	C
		0	1	2	2

1) Ambient Air Quality Monitoring: Concentration of particulate matter present in air (PM_{10} & $PM_{2.5}$), SOx and NOx by using High Volume Air Sampler.
2) Stack Sampling Techniques and Demonstration of Stack Monitoring: Concentration of particulate matter present in air (PM_{10} & $PM_{2.5}$), SO_2 and NOx and other parameters.
3) Exercises on Ambient Gas Monitoring including CO & VOC
4) Noise Isopleths in Institution or Industry.
5) TCLP – Leachate from Landfills.
6) Micrometeorology –Wind Direction, Wind speed, Humidity Temperature, Rainfall.
7) Exercises on Auto Exhaust Analyzer for Petrol Vehicle and Diesel Vehicle Smoke test for Diesel Vehicle.
8) To determine the Oil and Grease in sewage sample.
9) Sampling and laboratory analysis of solid waste – Percent Composition , Moisture Content , Density , Calorific Value, C/N Ratio , N, P, K , Total organic content , Boron.
10) Demonstration of Rain Gauges

II Semester	ENVIRONMENTAL PROCESS DESIGN AND DRAWING LABORATORY - IV	L	T	P	C
		0	1	2	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. Design and drawing of Garland drains, Rain water harvesting structures.
7. Neutralization and equalization tank for effluents from chemical and biological research labs.
8. Design and drawing of Gravitational Settlers
9. Design and drawing of Bag Filters
10. Design and drawing of ESP

Text Books:

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