

# **ACADEMIC REGULATIONS & COURSE STRUCTURE**

**For**

## **ENVIRONMENTAL ENGINEERING**

*(Applicable for batches admitted from 2016-2017)*



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

## I Semester

S. No.	Subject	L	P	Credits
1	Mathematics for Environmental Engineers	4	-	3
2	Environmental Chemistry and Microbiology	4	-	3
3	Environmental Hydrology and Hydraulics	4	-	3
4	Environmental Impact Assessment and Management	4	-	3
5	Elective – I I. Environmental Legislations and Management Systems II. Environmental Systems Analysis III. Environmental Biotechnology	4	-	3
6	Occupational Health, Safety and Hygiene	4	-	3
7	Environmental Engineering Laboratory	-	3	2
Total Credits				20

## II Semester

S. No.	Subject	L	P	Credits
1	Advanced Water and Waste Water Treatment	4	-	3
2	Air and Noise Pollution and Control	4	-	3
3	Solid and Hazardous Waste Management	4	-	3
4	Industrial Waste Water Management	4	-	3
5	Elective – II I. Design and Operation of Water and Waste Water Treatment Plants II. Agricultural Pollution and Control III. Bioremediation	4	-	3
6	Cleaner Production and Environmental Management	4	-	3
7	Computer Applications in Environmental Engineering	-	3	2
Total Credits				20

### III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	--	--	2
2	Seminar – I	--	--	2
3	Project Work Part – I	--	--	16
Total Credits				20

### IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				20

**I Year - I Semester**

<b>L</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>3</b>

**MATHEMATICS FOR ENVIRONMENTAL ENGINEERS**

**UNIT I**

Linear system – Gaussian elimination and Gauss – Jordan methods – Matrix inversion – Gauss Seidel method – Nonlinear equations – Regula-falsi and Newton- Raphson methods – interpolation – Newton’s and Lagrange’s interpolation.

**UNIT II**

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, Skewness and Kurtosis – Probability – conditional probability – Bayes’ theorem.

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

1. Introductory Methods of Numerical Analysis, by Sastry, SS. Prentice-Hal, 2<sup>nd</sup> Edition.
2. Nuemerial Algorithms, by Krishna Murthy & Sen, Affiliated East-West Press, 1991, 2<sup>nd</sup> edition.
3. Numerical Methods, by Balaguri Swami

**I Year - I Semester**

<b>L</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>3</b>

**ENVIRONMENTAL CHEMISTRY AND  
MICROBIOLOGY**

**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. 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—toxics 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. Parkin, 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 Grady & Grady.
4. Microbiology by Pelzer, Ecschan & N R Kreig.

**I Year - I Semester**

<b>L</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>3</b>

**ENVIRONMENTAL HYDROLOGY AND  
HYDRAULICS**

**UNIT - I**

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

**UNIT- II**

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

**UNIT - III**

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

**UNIT- IV**

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

**UNIT -V**

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

**REFERENCE BOOKS:**

1. Water and waste water Engineering by Fair, Gayer and Okun

I Year - I Semester

L	P	C
4	0	3

## ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

### UNIT I

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

### UNIT II

**EIA notification by Ministry of Environment and Forest (Govt. of India):**

Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring. Case studies in EIA.

### UNIT III

**Prediction and assessment of impact for air and noise environment:**

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

### UNIT IV

**Prediction and assessment of impact for water and soil environment:**

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

### UNIT V

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

**REFERENCE BOOKS:**

1. Canter R.L., Environmental Impact Assessment, Mc Graw Hill International Edition, 1997.
2. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.
3. Peter Watten (Eds.) - 'Environmental Impact Assessment Theory and Practice', Unwin Hyman, London ( 1988).

I Year - I Semester

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4	0	3

**ENVIRONMENTAL LEGISLATIONS AND  
MANAGEMENT SYSTEMS  
(Elective – I)**

**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.

**UNIT II**

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

**UNIT IV**

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

**UNIT V**

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

**REFERENCE BOOKS:**

1. CPCB, "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz "Environmental law and policy in India "Oxford University Press, New Delhi, 2001.
3. Greger I. Megregor, "Environmental law and enforcement", Lewis Publishers, 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)

## **ENVIRONMENTAL SYSTEMS ANALYSIS**

### **Elective - I**

#### **UNIT-I**

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

#### **UNIT- II**

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

#### **UNIT- III**

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

#### **UNIT -IV**

Probabilistic models - fuzzy models - Simulation models.

#### **UNIT- V**

Modern tools - Expert systems - Neural networks - Genetic Algorithm - Case studies.

#### **REFERENCE:**

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

## **ENVIRONMENTAL BIOTECHNOLOGY**

### **Elective - I**

#### **UNIT-I**

Environmental Biotechnology -Principles and concepts - usefulness to mankind. Degradation of high concentrated toxic pollutants-halogenated, non halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.

#### **UNIT II**

Biotechnological remedies for environmental pollution - decontamination of groundwater - Production of proteins

#### **UNIT III**

Biofertilizers – Physical, chemical and microbiological factors of composting – health risk – pathogens – odor management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology– extra cellular polymers – Microbial Systems in Biogas technology.

#### **UNIT IV**

Concept of rDNA technology – expression vectors – cloning of DNA  
– mutation –construction of microbial strains - radioactive probes - protoplast fusion technology – applications.

#### **UNIT V**

Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment- Environmental Risk assessment.

#### **REFERENCES:**

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

I Year - I Semester

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4	0	3

## OCCUPATIONAL HEALTH, SAFETY AND HYGIENE

### UNIT I

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

### UNIT II

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

### UNIT III

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

### UNIT IV

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

### UNIT V

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

**REFERENCES:**

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

**I Year - I Semester**

<b>L</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>3</b>	<b>2</b>

**ENVIRONMENTAL ENGINEERING LABORATORY**

1. Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods –
2. Settling Column Analysis for type II settling, Break point chlorination.
3. Determination of Dosage of lime-soda for removal of hardness.
4. Media preparation and inoculation – test for plate count – coliforms – fecal coliforms – E.coli – M.P.N. and M.F. techniques. Bioassay study
5. Sampling and analysis of ambient air for PM<sub>2.5</sub>, PM<sub>10</sub>, Oxides of nitrogen - Instrumental methods of analyses for particulates, HC, CO, NO<sub>x</sub>, SO<sub>2</sub>,
6. Noise Isopleths.
7. Stack Monitoring including wind speed, wind direction, Humidity and Temperature.

**REFERENCES:**

1. Sawyer, C.N. and McCarty, P.L. and Parkin, G.F. “Chemistry for Environmental Engineers”, 4th Edition, McGraw Hill, New Delhi, 1994.
2. De.A.K. “Environmental Chemistry “, New Age International Ltd., New Delhi, 1995.
3. “Standard Methods for the Examination of Water and Wastewater”, 21<sup>st</sup> Edition, American Public Health Association, Washington. D.C. 2005.
4. KVSG Murali Krishna, “Chemical Analysis of water and soil” A Laboratory Manual Reem Publications, New Delhi, 2010.

I Year - II Semester

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## ADVANCED WATER AND WASTEWATER TREATMENT

### UNIT I

**Physical and Chemical Treatment:** Screening, Grit removal, Aeration and gas transfer, Application of Membrane Processes, Reverse Osmosis, Micro-filtration, Nano-filtration, Ultrafiltration and Electrodialysis, Chemical precipitation, other solids removal operations, Control of odour, Control of volatile organic compounds.

### UNIT II

Theory of Sedimentation – flocculent particle settling – theory of coagulation and flocculation-zeta potential - Filtration - theory of granular media filtration – head loss cleaning of filter media - backwash hydraulics – Theory of chlorination – equilibrium constants.

### UNIT III

**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 – batch & continuous type

### UNIT IV

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

### UNIT V

**Anaerobic Treatment of Waste Water:** 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 generation.

### REFERENCE BOOKS

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

## **TEST BOOK**

1. KVSG Murali Krishna, “Industrial Water and Wastewater Management”, EPS, Kakinada, 2015.

I Year - II Semester

L	P	C
4	0	3

## AIR AND NOISE POLLUTION AND CONTROL

### UNIT-I

**Introduction:** Definition - Sources and classification of Air Pollutants - Photochemical smog - Effects of air pollution on health of Human & Animals, vegetation & materials, air quality, Global effects of air pollution, Carbon Credits and Carbon Trade, Energy Plantation

### UNIT-II

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

### UNIT-III

**Sampling and Particulate Pollution Control Methods:** Atmospheric sampling and stack sampling methods. Air quality standards. Types of particulate pollution control methods – Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators, design aspects and principles of these air pollution control units.

### UNIT-IV

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

### UNIT- V

Noise Pollution **and control** - Definitions – Significance in general - sources, measurement - effects and control measures, **Noise Isopleths, Noise Standards**, Noise legislations.

### TEXT BOOK

1. KVSG Murali Krishna. Air pollution and control, Laxmi Publications, New Delhi, 2015.

### REFERENCE BOOKS:

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

I Year - II Semester

L	P	C
4	0	3

## SOLID AND HAZARDOUS WASTE MANAGEMENT

### 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 system Optimization of collection routes– alternative techniques 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 Economics, Disposable Materials, Recycling Collection, Processing, 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. **Landfills:** Site selection, design and operation, drainage and leachate collection systems – designated waste landfill remediation.

### UNIT -IV

**Hazardous Waste Management:** Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste - sources, collection, treatment and reuse.

### UNIT- V

**Hazardous waste treatment and Design:** Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.

**REFERENCES:**

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

I Year - I Semester

L	P	C
4	0	3

## INDUSTRIAL WASTEWATER MANAGEMENT

### UNIT - I

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

### UNIT II

**Pollution Prevention & Unit operations:** Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy – Source & reduction techniques – Strength& volume Reduction - Material balance - Evaluation of Pollution prevention options - Waste minimization Circles. Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption -Photocatalysis  
– Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.

### UNIT III

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

### UNIT-IV

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

### UNIT-V

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

**REFERENCE BOOKS:**

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

**Test Book**

1. KVSG Murali Krishna, “Industrial Water and Wastewater Management”, EPS, Kakinada, 2015.

<b>I Year - II Semester</b>	<b>L</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>3</b>

**DESIGN AND OPERATION OF WATER AND  
WASTEWATER TREATMENT PLANTS  
Elective - II**

**UNIT I**

**Water Treatment:** Design of conventional water treatment units - Aeration, chemical dosing tanks, Flash mixers, Flocculators, Sedimentation tanks, Clariflocculators, filter beds, disinfection units - hydraulic profile and layout of conventional treatment units - upgrading of existing plants .

**UNIT II**

**Wastewater Treatment:** Design of sewage treatment plant units - screen chamber, Grit chamber, Trickling filters, Rotating Biological contactor, activated sludge process, oxidation ditches, aerated lagoons, waste stabilization ponds - hydraulic profile and layout of primary and secondary units.

**UNIT III**

Anaerobic treatment systems, septic tank and disposal system, Sludge management, Sludge thickening, sludge digestion , sludge dewatering (mechanical and gravity) - Upgrading existing plants .

**UNIT IV**

**Operation, Maintenance and Management:** Operation and maintenance of sewerage system- Operational problems of Treatment plants - Trouble shooting, Planning, Organizing and Controlling of treatment plant operations - Training of operating personnel.

**UNIT V**

**Industrial Water Treatment:** Design of softeners, Demineralisers, Desalination plants, Boiler feed water treatment - Residue management-Applications of wastewater design software.

**REFERENCE BOOKS:**

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

## **AGRICULTURAL POLLUTION AND CONTROL**

### **Elective - II**

#### **UNIT -I**

**Environmental issues in agriculture:** Types of farming systems, agro meteorology, water and nutrients requirement.

#### **UNIT -II**

**Fertilizers , pesticides, herbicides:** types of fertilizers, pesticides and other agrochemicals, soil and water conservation practices. Natural fertilizers, pesticides and herbicides- green practices in agriculture yield improvement.

#### **UNIT -III**

**Water logging and salinity:** causes and effects. Wastewater reuse in agriculture: management and control of agricultural waste; recycling and reuse.

#### **UNIT -IV**

Biotechnology in reduction of CO<sub>2</sub> emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications.

#### **UNIT -V**

**Novel methods of pollution control:** Methane production, Root zone treatment, Membrane technology.

#### **REFERENCE BOOKS:**

1. Microbial Biotechnology : A. N. Glazer and H. Nikaido .
2. Molecular Biotechnology : Gleek and Pasternack.
3. Biotechnology : A Text Book of Industrial Microbiology, T. D. Brock,
4. Industrial Microbiology : Prescott and Dunn.
5. Biotechnology : B. D. Singh , Kalyani Publishers.
6. T.V.Ramachandra, Soil & Ground Water Pollution from Agricultural activities, TERI

## **BIOREMEDIATION**

### **Elective -II**

#### **UNIT – I:**

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

#### **UNIT –II:**

Bioremediation strategies – remediation technologies - in situ and ex situ bioremediation- advantages and disadvantages of bioremediation.

#### **UNIT III:**

Microbial systems for bioremediation- genetic responses of microorganisms to the presence of pollutants- application of genetically engineered microorganisms for waste management.

#### **UNIT IV:**

Microbial transformation reactions- microbial detoxification-bioremediation systems and processes-microbial cleaning of gases-insitu bioremediation-lab scale bio treatability.

#### **UNIT V:**

Bioremediation of herbicides, pesticides, hydrocarbons, oil spills – Bioremediation of organic and inorganic pollutants-advances in microbial remediation

#### **TEXT BOOKS:**

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

**I Year - II Semester**

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## **CLEANER PRODUCTION AND ENVIRONMENTAL MANAGEMENT**

### **UNIT I**

**Introduction:** Sustainable Development – Indicators of Sustainability

- Sustainability Strategies- Barriers to Sustainability – Industrial activity and Environment – Industrialization and sustainable development – Cleaner Production (CP) in Achieving Sustainability –Principles Cleaner Production: Definition – Importance – Historical evolution – Benefits
- Promotion – Barriers – Role of Industry, Government and Institutions
- Industrial Ecology – clean development mechanism, reuse, recovery, recycle, raw material substitution.

### **UNIT II**

**Cleaner Production Project Development and Implementation:**

Overview of CP Assessment Steps and Skills, Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Preparing a Program Plan – Measuring Progress – 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 III**

Green Technology - Definition of green building, benefits and challenges, public policies and market-driven initiatives, effective green specifications. Overview of the Building Energy System Design Process. Assessing human functional and physiological smart growth- needs, local climate and free energy resources. Design scenarios- Day lighting, Electric Lighting.

### **UNIT IV**

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

## **UNIT V**

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

### **REFERENCES:**

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

**I Year - II Semester**

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**COMPUTER APPLICATIONS IN ENVIRONMENTAL  
ENGINEERING**

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