



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

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**COURSE STRUCTURE & SYLLABUS**  
**M.Tech**  
**ENVIRONMENTAL ENGINEERING Programme**  
*(Applicable for batches admitted from 2019-2020)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**



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**I SEMESTER**

S. No	Course	Course name	P.Os	category	L	T	P	Credits	Marks
1		Advanced Numerical Methods and Applied Statistics			3	0	0	3	100
2		Industrial Water and Wastewater Management			3	0	0	3	100
3		Elective –I a) Unit Operations and Processes in Water and Wastewater Treatment b) Environmental Hydrology and Hydraulics c) Remote Sensing and GIS Applications in Environmental Engineering			3	0	0	3	100
4		Elective –II a) Environmental Chemistry and Microbiology b) Urban Storm water Management c) Environmental Legislations and Management Systems			3	0	0	3	100
5		Research Methodology and IPR			2	0	0	2	100
6		Environmental Quality Monitoring Lab - I			0	0	4	2	100
7		Environmental Engineering and Microbiology Lab – II			0	0	4	2	100
8		Audit Course-1			2	0	0	0	100
<b>Total</b>					<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>	<b>800</b>

**Audit course 1:**

- The student shall register himself /herself at the beginning of 1<sup>st</sup> semester for any one of NPTEL / SWYAM/MOOC course offered by National institutes.**
- The student shall attend the examination conducted by the respective organization and produce the evaluation certificate before the project review committee for further evaluation and award of marks.**



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

**II SEMESTER**

S. No.	Course	Course Name	P.Os	category	L	T	P	Credits	Marks
1		Air and Noise Pollution Control			3	0	0	3	100
2		Solid and Hazardous Waste Management			3	0	0	3	100
3		Elective III a) Environmental Impact Assessment b) Green Technologies c) Environmental System Analysis			3	0	0	3	100
4		Elective IV a) Disaster Management b) Occupational and Environmental Health c) Air Quality Modelling and Management			3	0	0	3	100
5		Software applications in environmental engineering (lab –III)			0	0	4	2	100
6		Environmental process design and drawing (laboratory –IV)			0	0	4	2	100
7		Mini Project with Seminar			0	0	4	2	100
8		Audit Course-2			2	0	0	0	100
<b>Total</b>					<b>14</b>	<b>0</b>	<b>12</b>	<b>18</b>	<b>800</b>

**Audit course 2:**

- 1. The student shall register himself /herself at the beginning of 2<sup>nd</sup> semester for any one of NPTEL / SWYAM/MOOC course offered by National institutes.**
- 2. The student shall attend the examination conducted by the respective organization and produce the evaluation certificate before the project review committee for further evaluation and award of marks.**



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**III SEMESTER**

S. No.	Cours	Course Name	P.Os	Category	L	T	P	Credits	Marks
1		Program Elective – 5 a)Life cycle analysis b)Bio remediation c)Climate change and global environmental issues			3	0	0	3	100
2		Open Elective			3	0	0	3	100
3		Dissertation Phase - I (to be continued and evaluated next semester)			0	0	20	10	---
<b>Total</b>					<b>6</b>	<b>0</b>	<b>20</b>	<b>16</b>	<b>200</b>

**Dissertation phase I : Evaluation procedure**

- 1 The student shall attend for a formal VIVA- VOCE examination with an interim report on the work done by himself/herself in the 3<sup>rd</sup> semester of the course work, before the review committee.
- 2 The report shall comprise of a written document on the literature survey, problem identification, objectives of the work, and proposed methodology along with a power point presentation.

**IV SEMESTER**

S. No.	Course	Course Name	P.Os	Category	L	T	P	Credits	Marks
1		Dissertation Phase-II (continued from III Semester)			0	0	32	16	100
<b>Total</b>					<b>0</b>	<b>0</b>	<b>32</b>	<b>16</b>	<b>100</b>

**Dissertation phase II : Evaluation procedure**

- 1 The student shall attend for a formal VIVA- VOCE examination with the dissertation book on the work done by himself/herself in both the 3<sup>rd</sup> & 4<sup>th</sup> semesters of the course work, before the review committee.



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

**2 The dissertation book shall be in the specified format in compliance with the guide lines of university.**

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS</b>				

**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.



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**KAKINADA – 533 003, Andhra Pradesh, India**

**Text Book:**

1. “Numerical methods for engineers” - Steven C. Chapra, Raymond P. Canale - McGraw Hill higher education, 6<sup>th</sup> 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, 2<sup>nd</sup> edition.
2. “Advanced Engineering Mathematics”- Erwin Kreyszig, Wiley - India publication, 8<sup>th</sup> edition.
3. “Introductory Methods of Numerical Analysis” - Sastry S.S - 4th Edition, PHI Learning Pvt. Ltd., 2006.



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>INDUSTRIAL WATER AND WASTEWATER MANAGEMENT</b>				

#### **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.



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>UNIT OPERATIONS AND PROCESSES IN WATER AND WASTEWATER TREATMENT</b>				

### 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, 4<sup>th</sup> Edition New Delhi, 2003.
- 3 “Biological Processes Design for wastewaters” - Benefield, L.D. and Randall C.W., Prentice -Hall, Inc.Eaglewood Cliffs, 1982.
- 4 “Biological wastewater treatment: Theory and Applications” - Grady Jr. C.P.L and Lin H.C., Marcel Dekker, Inc, New York, 1980.

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





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**ENVIRONMENTAL HYDROLOGY AND HYDRAULICS**

**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



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	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>REMOTE SENSING &amp; GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING</b>				

### UNIT I

**Physics of Remote Sensing:** Sources of Energy, Electromagnetic Spectrum - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Active and Passive Radiation, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing, Fundamentals of Microwave Remote Sensing.

### UNIT II

**Remote Sensing:** Definition, Modes of Remote Sensing, Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections – Basic Pattern Recognition Concepts, Basic Principles of Visual Interpretation.

### UNIT III

**Satellite Data Analysis:** Visual interpretation – Digital Image Processing – Image Processing - Image Enhancement and Compression Techniques, Rectification, Classification Methods, Accuracy assessment - Digital Image analysis - DTM/DEM.

### UNIT IV

**Geographical Information Systems:** Definition, Basic Concepts of GIS, Map Projections and co-ordinate systems-Data Formats – Spatial and Non-spatial, Data base Management –Thematic mapping –Query Analysis -buffering and Neighbourhood Functions – Proximity Analysis - Overlay Analysis –Introduction to ArcGIS, Modelling Real World Features.

### UNIT V

**Geographic Data for Environmental Modelling and Assessment:** Geospatial techniques for planning and design of Water supply and Irrigation Systems - Geospatial technologies for Water Resources Monitoring and Forecasting - River Basin Management - Disaster Mapping - floodplain mapping and management - Air Quality Mapping - Wildlife Mapping - Land Use / Land Cover assessment - Site selection for engineered landfills, rainwater harvesting .

### Reference Books:

1. "Textbook on Remote Sensing in Natural Resources Monitoring and Management" - Agarwa C. S., and Garg, P. K., Wheeler Publishing, Allahabad, 2000
2. "Remote Sensing and Image Interpretation" - Lillesand, T. M., and Keifer, R. W., John Wiley & Sons, N York, 1994
3. "Introduction to the Use of Geographical Information Systems for Practical Hydrology" - Meijerink M. J., de Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., ITC publication no. 23, UNESCO, Paris, 1994



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**KAKINADA – 533 003, Andhra Pradesh, India**

4. “Remote Sensing – The Quantitative Approach Swain” - P. H., and Davis, S. M., McGraw Hill Pub. Co. N York, 1987

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ADVANCED NUMERICAL METHODS AND APPLIED STATISTICS</b>				

### Unit-I

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

### Unit-II

**Basics of Equilibrium chemistry:** Equilibrium Constants, Le-Chatlier 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:** Enzymes, factors affecting the action of Enzymes, (co-enzymes or cofactors, Temperature, pH, Micro and Macro mutants), Proteins, carbohydrates and fats.

### Unit-III

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

### Unit-IV

**Microbiology of drinking water:** Distribution of microorganisms - Indicator organisms, coliforms - faecal coliforms, E-Coli, Streptococcus, Clostridium, MPN and MFT - Algae in water supplies - problems and control.

### 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. “Chemistry for Environmental Engineering and Science” - C.N. Sawyer, P.L. McCarty and G.F. Perkin, 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.



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

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>URBAN STORM WATER MANAGEMENT</b>				

### **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



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

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ENVIRONMENTAL LEGISLATIONS AND MANAGEMENT SYSTEMS</b>				

### 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)



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<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>
<b>RESEARCH METHODOLOGY and IPR</b>					

**UNIT I- RESEARCH PROBLEM AND SCOPE FOR SOLUTION**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT II- FORMAT**

Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT III- PROCESS AND DEVELOPMENT**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

**UNIT IV- PATENT RIGHTS**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

**UNIT V- NEW DEVELOPMENTS IN IPR**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**TEXT BOOKS**

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

**REFERENCES**

1. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**  
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		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>ENVIRONMENTAL QUALITY MONITORING LAB</b>					

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 Solidsof 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.

<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>ENVIRONMENTAL ENGINEERING AND MICROBIOLOGY LAB</b>					



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**KAKINADA – 533 003, Andhra Pradesh, India**

- 1) Ambient Air Quality Monitoring: Concentration of particulate matter present in air (PM<sub>10</sub> & PM<sub>2.5</sub>), SO<sub>2</sub> and NO<sub>x</sub> by using High Volume Air Sampler.
- 2) Stack Monitoring: Concentration of particulate matter present in air (PM<sub>10</sub> & PM<sub>2.5</sub>), SO<sub>2</sub> and NO<sub>x</sub> 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.





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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: MANUSCRIPT WRITING AND EDITING</b>				

**UNIT I: INTRODUCTION**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT II: COMPONENTS**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

**UNIT III: REVIEW OF LITERATURE**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

**UNIT IV: SKILLS**

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V: SUBMISSION**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**TEXT BOOKS:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011



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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: DISASTER MANAGEMENT</b>				

**UNIT I- INTRODUCTION**

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

**UNIT II- REPERCUSSIONS OF DISASTERS AND HAZARDS:**

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT III- DISASTER PRONE AREAS IN INDIA**

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

**UNIT IV- DISASTER PREPAREDNESS AND MANAGEMENT**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

**UNIT V- RISK ASSESSMENT**

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Disaster Mitigation-Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**TEXT BOOKS**

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New Royal book Company.

**REFERENCES**

1. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
- 2 . Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.



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<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: BIOSAFETY</b>					

**UNIT I INTRODUCTION**

Introduction to biotechnology entrepreneurship: strategies in biotechnology led ventures, biotechnology driven business opportunities, major hurdles and barriers in biotechnology driven ventures and their solutions,

**UNIT II COST BUDGET AND INVEST**

Understanding company Law and commercial knowhow for biotechnological ventures, costing and capital budgeting in biotechnological ventures. Investing in biotechnology driven business, concept of biotechnology incubation center for knowledge-based industry.

**UNIT III INTELLECTUAL ISSUES**

Biotechnology and Intellectual issues: Introduction to Biotechnology in agriculture, medicine and industry, Biotechnology and its development in developing countries, patent eligibility issues in life science innovations: case study, checks and balances in biotechnology related patents, the importance of entrepreneurship in biotechnology, Intellectual property issues in agriculture, industrial and Pharmaceutical Biotechnology.

**UNIT IV BIOHAZARD IDENTIFICATION**

Biohazard identification: microbial flora of human and microbial virulence factors, indigenous and pathogenic agents of research animals, laboratory, growth chamber and green house microbial safety,

**UNIT V EPIDEMIOLOGY**

Epidemiology of laboratory associated infections, biohazard assessment, risk assessment of biological hazards, biohazard control, administrative control, special considerations for Biosafety.

**TEXT BOOKS:**

1. Craig Shimasaki, Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press, 2014
2. James F. Jordan, Innovation, Commercialization, and Start-Ups in Life Sciences, CRC Press; 1 edition 2014
3. Frank S. David, The Pharmagellan Guide to Biotech Forecasting and Valuation, Pharmagellan; 1st edition, 2017
4. Harikesh Bahadur Singh, Intellectual Property Issues in Biotechnology, CABI 1st edition, 2016
5. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer Nature; 2015 edition
6. Matthew Rimmer, Intellectual Property & Biotechnology: Biological Inventions, Edward Elgar, 2008
7. Goel and Parashar, IPR, Biosafety and Bioethics, Pearson Education India; First edition 2013 Diane O. Fleming (Editor), Debra L. Hunt, Biological Safety: Principles And Practices, ASM Press, 4th Edition



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: VALUE EDUCATION</b>				

**UNIT I- INTRODUCTION**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

**UNIT II- VALUES**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT III- PERSONALITY DEVELOPMENT**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

**UNIT IV- COMPETENCE**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women.

**UNIT V- IMPLEMENTATIONS**

All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

**TEXT BOOKS**

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**  
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<b>I Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: CONSTITUTION OF INDIA</b>					

**UNIT I- INTRODUCTION**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working).

Philosophy of the Indian Constitution: Preamble Salient Features

**UNIT II- CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies Directive Principles of State Policy, Fundamental Duties.

**UNIT III- ORGANS OF GOVERNANCE:**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

**UNIT IV- LOCAL ADMINISTRATION:**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

**UNIT V- ELECTION COMMISSION:**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**TEXT BOOKS**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

**REFERENCES:**

1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: PEDAGOGY STUDIES</b>				

**UNIT I- INTRODUCTION AND METHODOLOGY:**

Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

**UNIT II- THEMATIC OVERVIEW**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

**UNIT III- EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES.**

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT IV- PROFESSIONAL DEVELOPMENT:**

Alignment with classroom practices and follow-up support. Peer support Support from the head teacher and the community. Curriculum and assessment. Barriers to learning: limited resources and large class sizes

**UNIT V- RESEARCH GAPS AND FUTURE DIRECTIONS**

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact

**TEXT BOOKS**

- 1 Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

**REFERENCES:**

1. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
2. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.



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3. [www.pratham.org/images/resource%20working%20paper%202.pdf](http://www.pratham.org/images/resource%20working%20paper%202.pdf).

<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: STRESS MANAGEMENT BY YOGA</b>				

**UNIT I- INTRODUCTIONS**

Definitions of Eight parts of yog. ( Ashtanga )

**UNIT II- PARTS**

Yam and Niyam.

**UNIT III- DO'S AND DON'T'S IN LIFE.**

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**UNIT IV- BREATHING EXERCISES**

Asan and Pranayam

**UNIT V- TYPES**

i) Various yog poses and their benefits for mind & body

ii) Regularization of breathing techniques and its effects-Types of pranayam

**TEXT BOOKS**

1. 'Yogic Asanas for Group Training-Part-I' :Janardan Swami Yogabhyasi Mandal, Nagpur

**REFERENCES:**

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata



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<b>I Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AUDIT COURSE 1: ROAD MAP FOR PATENT CREATION</b>				

**UNIT I INTRODUCTION**

Introduction to patent – Definition and concepts

**UNIT II- ANALYTICS**

Patent analytics- Introduction, How to a read patent?

**UNIT III RESEARCH GAP AND PLANNING**

Use of patent data for research gap analysis Identification of potential patent - various tools Research planning and patent -ling activity

**UNIT IV TYPES AND MAINTENANCE**

Types of patent and patent timelines Maintenance of laboratory notebook and patenting activity

**UNIT V INTERACTIONS**

Interaction with patent attorney at various stages of patenting and related timelines to be followed

**TEXT BOOKS:**

1. Petherbridge, L. (2007). Road map to revolution-patent-based open science. *Me. L. Rev.*, 59, 339.





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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>AIR AND NOISE POLLUTION CONTROL</b>				

### **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.



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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>SOLID AND HAZARDOUS WASTE MANAGEMENT</b>				

### **UNIT I**

**Solid wastes:** Generation and Composition: 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.

### **UNIT II**

**Collection and Transport of Solid Wastes:** 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. - Collection and processing of recyclable, reusable and disposable materials.

### **UNIT III**

**Processing and Treatment:** Source reduction and waste minimization - Unit operations for separation, processing and recovery of materials and metals Waste transformation through combustion, Incineration, pyrolysis, composting, anaerobic methods – Energy recovery – biogas generation

### **UNIT IV**

**Landfills:** Classification, Site selection, design and operation, methods of filling, drainage and leachate collection systems – 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- physical, chemical and thermal treatment of hazardous waste. e-Waste and plastic waste - sources, collection, design and operation of facilities, salvage, reuse and recovery – Solidification, chemical fixation and encapsulation, incineration – reuse after treatment.

### **Text book:**

1. M N Rao “Solid and hazardous waste management” – B S publications, Hyderabad, 2018.

### **References:**

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



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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>ENVIRONMENTAL IMPACT ASSESSMENT</b>				

### **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.



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**KAKINADA – 533 003, Andhra Pradesh, India**

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>GREEN TECHNOLOGIES</b>				

**UNIT- I**

**Introduction to 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.

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

**ENVIRONMENTAL SYSTEMS ANALYSIS**

**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.

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	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DISASTER MANAGEMENT</b>				

**UNIT-I: Types of Disasters:**



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

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.

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>OCCUPATIONAL, ENVIRONMENTAL HEALTH AND SAFETY</b>				

**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



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

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

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>AIR QUALITY MODELLING AND MANAGEMENT</b>				

**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



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

for SO<sub>2</sub> and NO<sub>2</sub>-Analytical methods for rare elements, anions, cations, PAN compounds etc-Online monitoring-State of art analysis for CO, O<sub>3</sub> 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 and sensitivity analysis-Calibration and validation of models-Performance evaluation of models.

**5. AIR QUALITY MANAGEMENT:**

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

**Reference**

1. M.N.Rao , Air Pollution, McGraw Hill Education (India) Pvt Ltd.
2. 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.





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

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>SOFTWARE APPLICATIONS IN ENVIRONMENTAL ENGINEERING</b>				

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. Storm 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](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>



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

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ENVIRONMENTAL PROCESS DESIGN AND DRAWING</b>				

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.



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

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>MINI PROJECT WITH SEMINAR</b>				

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. )



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

<b>II Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>LIFE CYCLE ANALYSIS</b>				

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**Reading:**

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



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

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

#### **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.



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

<b>II Year - I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>CLIMATE CHANGE AND GLOBAL ENVIRONMENTAL ISSUES</b>				

**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.

**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**

UNFCCC – 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, Kleindorfer P. R. et al (ed.), Edward Elgar, 1996.
5. “Climate Change – An Indian Perspective” - Dash Sushil Kumar, , Cambridge University Press India Pvt.Ltd, 2007



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

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>AIR AND NOISE POLLUTION CONTROL</b>				

### 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.

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



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

**ENVIRONMENTAL IMPACT ASSESSMENT**

**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.

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





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

**DISASTER MANAGEMENT**

**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.



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

<b>II Year - I Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>20</b>	<b>10</b>
<b>DISSERTATION</b>					

**\* Evaluated and displayed in 4<sup>th</sup> Semester marks list**

**\*\* Students Going for Industrial Project / Thesis will complete these courses through MOOCS**

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.



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

<b>II Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>32</b>	<b>16</b>
<b>DISSERTATION</b>				

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme