

**SYLLABUS for M.Sc. Environmental Science**  
**Choice Based Credit Systems (Semester Pattern)**  
**Rashrasant Tukdoji Maharaj Nagpur University, Nagpur**  
**w.e.f. from 2018-19**

Candidates opting for this course are advised to go through the direction relating to the course “DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)” which is available on R. T. M. Nagpur University website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Environmental Science

<b>M. Sc. Environmental Science Semester I</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
<b>1T1</b>	Environmental Chemistry	4	-	4	4	3	80	20	100	40	-	
<b>1T2</b>	Atmospheric Science	4	-	4	4	3	80	20	100	40	-	
<b>1T3</b>	Environmental Biology	4	-	4	4	3	80	20	100	40	-	
<b>1T4</b>	Environmental Microbiology and Biotechnology	4	-	4	4	3	80	20	100	40	-	
<b>1P1</b>	Environmental Chemistry and Atmospheric Science	-	8	8	4	3 - 8	100	-	100	-	40	
<b>1P2</b>	Environmental Biology, Environmental Microbiology and Biotechnology	-	8	8	4	3 - 8	100	-	100	-	40	
<b>1S1</b>	<b>Seminar - I</b>	2	-	2	1	-	-	25	25	10	-	
	<b>Total :</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>	<b>-</b>	<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Environmental Science Semester II</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
<b>2T1</b>	Environmental Ecosystem and Biodiversity	4	-	4	4	3	80	20	100	40	-	
<b>2T2</b>	Natural Resources Management	4	-	4	4	3	80	20	100	40	-	
<b>2T3</b>	Environmental Sampling and Research Methodology	4	-	4	4	3	80	20	100	40	-	
<b>2T4</b>	Analytical Techniques for Environmental Monitoring	4	-	4	4	3	80	20	100	40	-	
<b>2P1</b>	Environmental Ecosystem and Management & Natural Resources management	-	8	8	4	3 - 8	100	-	100	-	40	
<b>2P2</b>	Industrial chemistry & Analytical techniques	-	8	8	4	3 - 8	100	-	100	-	40	
<b>2S1</b>	<b>Seminar - II</b>	2	-	2	1	-	-	25	25	10	-	
	<b>Total :</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>	<b>-</b>	<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Environmental Science Semester III</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
<b>3T1</b>	Physico-Chemical Treatment of Water & Waste Water	4	-	4	4	3	80	20	100	40	-	
<b>3T2</b>	Biological Process in Wastewater Treatment	4	-	4	4	3	80	20	100	40	-	
<b>3T3</b> <b>3T3</b>	<b>(ELECTIVE-I)</b> - Water and Water Treatment <b>OR</b> <b>Paper XII - (ELECTIVE-II)</b> Water Supply and Resources	4	-	4	4	3	80	20	100	40	-	
<b>3T4</b> <b>3T4</b>	<b>FOUNDATION-I</b> Fundamentals of Environmental Science- I <b>OR</b> <b>Core (Subject Centric)-1</b> - Advance Water & Waste Water Treatment	4	-	4	4	3	80	20	100	40	-	
<b>3P1</b>	Physico-chemical treatment of water and waste water AND Biological process in waste water Treatment	-	8	8	4	3 - 8	100	-	100	-	40	
<b>3P2</b>	A) <b>(ELECTIVE-I)</b> Water & Water Treatment <b>OR</b> B) <b>(ELECTIVE-II)</b> Water Supply and Resources	-	8	8	4	3 - 8	100	-	100	-	40	
<b>3S1</b>	<b>Seminar - III</b>	2	-	2	1	-	-	25	25	10	-	
	<b>Total :</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>	<b>-</b>	<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Environmental Science Semester IV</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
<b>4T1</b>	Air and Noise Pollution Control Technology	4	-	4	4	3	80	20	100	40	-	
<b>4T2</b>	Solid and Hazardous Waste Management	4	-	4	4	3	80	20	100	40	-	
<b>4T3</b>	<b>(ELECTIVE-I)</b> Environmental Impact Assessment and Legislation	4	-	4	4	3	80	20	100	40	-	
<b>4T3</b>	<b>(ELECTIVE-II)</b> Environmental Management											
<b>4T4</b>	<b>FOUNDATION -II</b> Fundamentals of Environmental Science- II	4	-	4	4	3	80	20	100	40	-	
<b>4T4</b>	<b>OR</b> <b>Core (Subject Centric)-II</b> DISASTER MANAGEMENT											
<b>4P1</b>	Air and Noise Pollution Control Technologies AND Solid and Hazardous Waste Management AND EIA & Legislation	-	8	8	4	3 - 8	100	-	100	-	40	
<b>4P2</b>	<b>Project</b>	-	8	8	4	3 - 8	100	-	100	-	40	
<b>4S1</b>	<b>Seminar - IV</b>	2	-	2	1	-	-	25	25	10	-	
	<b>Total :</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>	<b>-</b>	<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

**Semester I**  
**Paper I**  
**Environmental Chemistry (1T1)**

**Unit I**

**Fundamentals of Chemistry**

**General Chemistry:** Solution, Mole concept, Normality, Molarity, Molality, Molar solution, Standardization, Primary standards, Secondary standards, Blank titration. Measurement of Temperature, Volume, Density, Viscosity & their Uses.

**Basic Concepts from Quantitative Chemistry:** Buffers & pH, Colorimetry, Lambert's Law, Beer's Law. Principles of Colloidal Chemistry, Emulsions, Carbonate and Bicarbonate, Saturated & Unsaturated Hydrocarbons.

**Physical Chemistry:** Gibb's Energy, Chemical Potential, Chemical Equilibria, Chemical Reactions, Solubility Product, Solubility of Gases in Water, Stoichiometry, Principles of Oxidation and Reduction, Adsorption & Absorption.

**Unit II**

**Introduction to Environmental Chemistry:** Basic Principles Involved in the Analysis Various Constituents Present in the Environment, Water Structure and Anomalous Behavior of Water, Definition, Scope & Importance of Environmental Chemistry.

**Green Chemistry for Sustainable Future:** Reagents, Media, Special Importance of Solvents, Water the Greenest Solvents, Synthesis and Processing Pathways, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry.

**Unit III**

**Soil Chemistry:** Introduction to Soil Chemistry, Composition, Soil Profile, Formation of Soil, Physico- Chemical Properties of Soil, Soil Reactions (Cation & Anion Exchange Phenomenon), Classification of Soils and their Characteristics, Major Nutrients of Soil, Nitrogen Pathways and NPK in Soils. Biofertiliser and their Types. Humus Formation, Nature and Properties of Humus, Clay-Humus Complex, Significance of C:N Ratio.

**Soil Pollution:** Definition of Soil Pollution, Sources, Consequences, and Control Measures. Land Use Planning, Soil Surveys in Relation to Land Use Planning, Methods of Site Selection and Evaluation. Bioremediation and Restoration of Contaminated Soil.

**Unit IV**

**Industrial Chemistry:** Classification of Industries Based on Environmental Impacts, Criteria for Selection of Site for Establishment of Industry, Socio-economic and Environmental Impacts of Industries, Legal and Statutory Requirements, Manufacturing Process and the Sources of Wastes, Characterization & Treatment of Industrial Waste with respect to Paper and Pulp, Tannery, Textile, Dairy, Sugar, Petrochemical, Pharmaceutical, Oil Refinery and Power Plants-Thermal, Gas Based and Hydroelectric.

**Books for Reference**

01. **Environmental Chemistry** : B. K. Sharma & H. Kaur( Goel Publishing House, Meerut )
02. **Industrial Chemistry** by B. K. Sharma ( Goel Publishing House, Meerut )
03. **Environmental Chemistry** : A.K.Dey,(Wiley Eastern Ltd),1987.
04. **A Text book of Environmental Chemistry** : O.D.Tyagi, M.Mehra (Anand Publications Pvt,Ltd) 1994.
05. **Elements of Environmental Chemistry** : H. V. Jadhav ( Himalaya,Publishing House)1992.
06. **Water Pollution and disposal of Waste water on Land** : U. N. Mahida ( Tata Mc-Grew Hill Publishing Company, New Delhi )
07. **Environmental Chemistry** : J. W. Moore and F. A. Moore (Academic press, New Delhi), 1976

08. **Global Environmental Chemistry** : Parashar, Sharma, Mitra, ( Narosa Publishing House, New Delhi ), 1998
09. **Environmental Chemistry** : Samir K. banerji ( Prentice Hall, New Delhi )
10. **Environmental Chemistry with Green Chemistry** by Asim K. Das. Books and Allied (P) LTD. Kolkata.

**Semester I**  
**Paper II**  
**Atmospheric Science (1T2)**

**Unit I**

**Fundamentals of Atmospheric Science:** Composition, Structure & Evolution of Atmosphere, Segments of Environment, Modern Views Regarding the Structure of the Atmosphere, Earth Radiation Balance, Particles, Ions and Radicals in the Atmosphere. Temperature inversion and Lapse rate.

**Unit II**

**Climatology:** Definition and Scope, Aims and Objectives of Climatology, Insolation-Factors Affecting the Distribution of Insolation. Atmospheric Depletion of Solar Radiation. Process of Heat Energy Transfer- Radiation, Conduction and Convection. Hydrological cycle, Evaporation, Condensation, Forms of Condensation – Dew, Frost, Fog, Mist, Smog. Cloud Formation, Classification of Clouds and Role of Clouds in Weather Forecasting.

**Unit III**

**Meteorology:** Definition, and Scope, Aims and Objectives of Meteorology. Primary Meteorological Parameters and their Measurement—Temperature, Wind Direction and Wind Speed. Secondary Meteorological Parameters and their Measurement—Humidity, Relative Humidity, Absolute Humidity, Pressure and Solar Radiation. Collection and Analysis of Wind Data, Wind Roses, Plotting of Wind Roses and Pollution Roses. Effects of Meteorological Parameters on Air Pollution.

**Unit IV**

**Global Climate Change:** Introduction, Sources and Effects of Green House Gases- O<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>O, NH<sub>3</sub>, N<sub>2</sub>, NO, NO<sub>2</sub>, NO<sub>3</sub>, CH<sub>4</sub> and CFCs. Atmospheric Ozone, Mechanism of Ozone Depletion, Effects of Ozone Depletion, Climatic Effects and Environmental Disturbances due to Ozone Depletion, Advance Research to Protect the Ozone Layer, Antarctic Ozone Hole and Consequences. Green House Effect, Effect on Global Climate, Consequences & Control. Implications of Climate Change, Monitoring, Assessment, Research and Prediction Programs, El-Niño and La-Niño.

**Books for Reference**

01. **General Meteorology:** H. R. Byers, Tata McGraw Hill Publications, New Delhi
02. **Climatology: Fundamentals and Applications:** Mater J. R.
03. **Climatology: Selected Applications:** Henry D. Foth
04. **Introduction to weather and climate:** Trewartha
05. **The Atmosphere: An Introduction to Meteorology:** Fedrik K. Lutgen, E. J. Tarbuck
06. **General Meteorology:** H. R. Byers (Tata Mc Grew – Hill Publications, New Delhi)
07. **Meteorology:** Dr. S.R. Gadekar, Agromate Publishers, Nagpur 2000
08. **Environmental Analysis:** M.M. Saxena, Agrobotanical Publisher, Bikaner 1994
09. **Climatology:** D.S. Lal, Shraddha Pustak Bhavan Alahabad, 2001
10. **Atmosphere, Weather and Climate:** K. Siddhartha, Kisalaya Publication Pvt. Ltd 2000

**Semester-I**  
**Paper III**  
**Environmental Biology (1T3)**

## Unit I

**Introduction to Ecology:** Definition, Scope, Branches of Ecology, Application and Significance, Ecological Landmark, Ecological Status in India.

**Environmental Factors:** Abiotic and Biotic, Limiting Factors, Leibig's Law, Shelford's law. Ecological Indicators.

**Ecological Relationship:** Intraspecific Relationship and Interspecific Relationship, Neutralism, Commensalism, Mutualism, Antagonism, Antagonistic Relationship, Symbiosis, Competition, Prediction, Parasitism and Symbiotic Relationship.

## Unit II

**Population Ecology:** Basic Concepts and Characteristics of Population, Population Dynamics, Biotic Potential, Prey- Predator Relationship, Concept of Carrying Capacity and Distribution of Population, Dispersion and Migration of Population, Factors Affecting Dispersion and Migration, Environmental Resistance.

## Unit III

**Community Ecology:** Definition, Composition, Functions and Characteristics, Stratifications, Periodicity, Fluctuations, Eco-tone and Edge Effect, Ecological Niche, Eco-types, Classification, Structure, Features, Stability and Evolution of Community, Role of Plants, Animals and Microorganisms. Ecological Succession, Types of Succession, Process, Pattern and Significance, Models of Succession.

## Unit IV

### Environmental Toxicology:

**Ecotoxicology:** Definition & Principle, Dose – Effect and Dose-Response Relationship- Frequency and Cumulative Response, Synergism and Antagonism, Lethal and Non Lethal Effects, LD<sub>50</sub>, Factors Influencing Toxicity- Biological, Chemical and Ecological. Biotransformation and Bioconcentration- Degradable and Non Degradable Toxic Substances, Food Chain and Biomagnifications, Environmental Fate of Pollutants- Dispersion and Circulating Mechanism of Pollutants. Toxicity Testing: Principles and Procedure- Bio-assays, Aquatic Toxicity Test, Stastical Test, Statistical Concept of LD<sub>50</sub>.

**Chemical Toxicology:** Toxic Chemical in the Environment (Air, Water and Soil), Impact of Toxic Chemicals on Enzymes, Biochemical Effects of Arsenic, Cadmium, Lead and Mercury. Biochemical Effects of Pesticides and Cyanides: Carcinogens, Mutagens and Tetrogens.

### Books for Reference

01. **Fundamentals of Ecology:** Eugene P. Odum, ( Natraj Publishers, Dehradun.)
02. **Principles of Ecology:** P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi)
03. **Environmental Biology:** P. D. sharma ( Rastogi Publications, Meerut )
04. **Ecology and Environment:** P. D. sharma ( Rastogi Publications, Meerut )
05. **Principles of Environmental Biology :** P. K. G. Nair ( Himalaya Publishing House, New Delhi )
06. **Environmental Biology:** M. P. Arora ( Himalaya Publishing House, New Delhi)
07. **Ecology and Field Biology:** Robert Leo Smith (Harper Collins college publication)
09. **General Ecology:** H. D. Kumar (Vikas Publishing house, New Delhi)
10. **Toxicology – Principles & Methods:** M. A. Subramanian, MJP, Publishers, Chennai (2004).

## Semester-I

### Paper IV

### Environmental Microbiology and Biotechnology (1T4)

## Unit I

**Introduction to Environmental Microbiology:** Introduction, Scope, Importance of Environmental Microbiology, Structure of Microorganisms-Fungi, Bacteria, Virus, Classification of Microorganisms, Microbial Diversity. Role of Microorganisms in Air, Water and Soil for Microbial Qualities, Environmental Aspects of Infectious Diseases (Water Born Diseases), Bioremediation and its Role in Environmental Management, Control of Pest and Disease by Microorganism. Role of Microbes in Sewage (Trickling Filter, Activated sludge Process and Oxidation Pond Process).

## Unit II

**Microbial Methods:** Types of Culture, Sterilization and Disinfection, Techniques used of Enrichment of Culture, Method of Pure Culture, Preparation, Maintenance and Preservation of Microbial Culture (Pour plate, Streak plate and Spread plate).MPN and SPC.

## Unit III

**Environmental Biotechnology:** Introduction, Basic of Environmental Biotechnology, Definition and Scope of Biotechnology, Biotechnological Approach of Environmental Pollution, Energy Management and Abatement Bioremediation, Reclamation and Restoration.

## Unit IV

**Environmental Biotechnology for Environmental Protection:** Scope of Biotechnology in Pollution Control, In-situ and Ex-situ Bioremediation, Phytoremediation- Metal Phytoremediation, Organic Phytoremediation, Microbes used in Pollution Mitigation, Environmental Biotechnology and Sustainability, Bio-control Agents- Bio-Pesticides, Bio-Insecticide, Mushroom Cultivation and Vermiculture. Bioethics and Biosafety.

### Books for Reference

- 01. General microbiology Volume I & II :** C. B. Powar & H. F. Dagainawala ( Himalaya publishing House, Mumbai ), 2002
- 02. Fundamental principles of Bacteriology (TMH Edition):** A. J. Salle, (Tata McGraw-Hill Publishing Company Limited, New Delhi), 1974
- 03. Microbiology :** P. D. Sharma ( Rastogi publication Meerut )
- 04. Microbiology:** Pelizer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi ),
- 05. Hand book of Microbiology:** Yu. S. Krivashein ( Mir Publishers Mascow )
- 06. Microbiology for Environmental Engineering :** M. C. Kinnery ( Tata McGraw-Hill Publishing Company Limited, New Delhi ),
- 07. Applied Microbiology:** Vimta Kale & Kishore Bhusari ( Himalaya Publishing House, Mumbai )
- 08. Soil Microbiology:** Martin Alexander, Wiley Eastern Limited, 1981
- 09. Environmental Biotechnology:** S. N. Jogdand, Himalaya Publishing House, Mumbai (2006).
- 10. A Textbook of Biotechnology:** R. C. Dubey, S. Chand & Company, New Delhi (2002).

## SEMESTER - I

### PRACTICAL – I

#### ENVIRONMENTAL CHEMISTRY AND ATMOSPHERIC SCIENCE (1P1)

- Laboratory concepts: Rules and regulation, preparation of standard solutions.
- Weighing capacity and sensitivity of balance –care and use of balance.
- Water sampling and storage techniques.
- Examination of water quality with respect to following parameters
  - pH, conductivity, density, viscosity, turbidity, colour.
  - Acidity, Alkalinity, TDS & DO
- Study of adsorption of colour on activated charcoal and verification of Freundlich's



6. Determination of Iron 1:10, O- Phenanthroline method
7. Physical properties of soil: Determination of textured and particle size distribution (sand, silt and clay) porosity, water holding capacity, electrical conductivity and infiltration rate.
8. Metrology of air pollution :
  - a) Determination of wind velocity and direction by anemometers
  - b) Determination of relative humidity by psychomotor

## SEMESTER - I PRACTICAL – II

### ENVIRONMENTAL BIOLOGY, ENVIROMENATAL MICROBIOLOGY AND BIOTECHNOLOGY (1P2)

1. Estimation of primary productivity by light and dark Bottle method
  - a) Study of macrophytes lake
  - b) Effects of light/pollutants on photosynthetic activity
2. Analysis of lakes ecosystem with special reference to their conservation and management
3. Isolation of bacteria from soil water & air
4. Collection and handling of water sample for bacterial analysis with respect to
  - a) Standard plate count at 370c
  - b) Coli form count by MID & MPN technique
  - c) MF Techniques for coli forms
5. Bioassay test with fish/snail Determination of LC-50 value using pollutants (heavy metals/ instructions, acute and chronic toxicity to study the effects of toxicity
6. Identification and enumeration of Phytoplankton in surface water
7. Identification and enumeration of Zooplankton in surface water
8. Collection of affected leaves from road side plantation and its comparison with reference plants.

## Semester II Paper V

### Environmental Ecosystem and Biodiversity (2T1)

#### Unit I

**Introduction to Ecosystem:** Concepts, Structure, Functions and Types of Ecosystem, Abiotic and Biotic Components, Energy flow and Energy Dynamics of Ecosystem, Food Chains, Food Web, Tropic Levels, Biogeochemical Cycles (Carbon, Nitrogen, Phosphorus and Sulphur), Basic Concept of Productivity, Productivity of Different Ecosystem, Measurement of Productivity and the Factor Affecting the Productivity.

#### Unit II

**Wildlife Conservation in India:** Importance of Conservation, Reason for extinction of wildlife, Classification of Scarce Wildlife, History of Wildlife Conservation, Wildlife Conservation in India, Endangered Species of India, Hot Spot Biodiversity in India.

**Biomes and Conservation of Forest:** Biomes of the World with Special Emphasis on Indian Biomes, Characteristics Features and Different Types of Ecological Indicator. Forest and its Ecological Significance, Major Types of Forest, Deforestation and its Causes, Forest Management, “Chipko Movement”, Afforastation, Social Forestry, Conservation, Legislation, National Forest Policy, Joint Forest Management.

#### Unit III

**Biodiversity:** Definition, Level and Types of Biodiversity, Concept, Significance, Magnitude & Distribution of Biodiversity, Trends, Biogeographically Classification of India, Values of Biodiversity, Impact of Biodiversity, Biodiversity at Global, National & Regional Level.

**Status of India's Biodiversity:** Methods for Monitoring Biodiversity Trends, Hotspots of Biodiversity, Threats to Biodiversity and Causes of Extinction, IUCN Categories, Red Data Book, Endangered Species, Vulnerable Species, Restricted Species, Man & Wildlife Conflicts, Methods of Wildlife Conservation Project Tiger, Project Elephant and Project Crocodile. Ecological Consequences of Reduction in Biodiversity, Brief Account of Endangered Flora & Fauna of India.

#### Unit IV

**Biodiversity Conservation Strategies:** 'Ex-situ' Conservation (Zoos) 'In-situ' Conservation (National Parks and Sanctuaries), Restoration of Wilderness and Green Cover, Imparting Education.

**Biodiversity Action Plan:** Global Agreement and National Concerns, Sustainable Utilization, Research and Developmental Activities, Education and Training Research, National Policy and Action Plan, Role of Forest Department in Conservation, Conservation of Domestic Cultivators, Integrated Protected Area System, RAMSAR Sites, and Convention on Biological Diversity (CBD), Implementation Process in India. Biodiversity Legislation, Diversity Act 2002, Biodiversity Rules 2004.

#### Books for Reference

01. **Environmental Biology:** P. D. Sharma, Rastogi Publications, Meerut.
02. **An Introduction to Environmental Management:** Dr. Anand S. Bal, Himalaya Publishing House, New Delhi.
03. **Introduction to Social Forestry:** Sitaram Rao, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, 1979.
04. **Environmental Biology:** P. S. Verma & V. K. Agarwal, S. Chand & Company, New Delhi (2004).
05. **Environmental Science:** S.C. Santra, New Central Book Agency, Kolkata (2001).
06. **Environmental Biology:** M. P. Arora, Himalaya Publishing House, New Delhi.
07. **Environmental Science:** Charles E. Kupchella and Margaret C. Hyland, Allyn and Bacon, Inc., Biston (1986)
08. **A Textbook of Environmental Studies:** G. R. Chatwal & Harish Sharma, Himalaya Publication House, New Delhi, (2004).
09. **Environmental Biology:** K.C. Agarwal, Agro-Botanica Bikaner.
10. **Fundamentals of Ecology:** M.C. Dash, Tata McGraw Hill Publishing Company Ltd, New Delhi.

### Semester II

#### Paper VI

#### Natural Resources Management (2T2)

##### Unit I

**Natural Resources:** Conservation and Management, Definition, Broad Classification, Renewable, Non Renewable and Mineral Resources.

**Renewable (Non Conventional Source of Energy):** Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Biomass energy (Bio Gas), Ocean Energy and Magneto- hydrodynamic Power (MHD), Impact on Environment and their applications, Energy Production Consumption and Energy use pertain in different part of the world.

**Non Renewable (Conventional Source of energy):** Thermal Power, Hydro Energy Atomic Energy, Nuclear Energy (Fission and Fusion) and Fossil fuels (Coal, Petroleum Oil and natural Gas).

##### Unit II

**Conservation of Energy:** Importance, Methods of Conservation, Barriers to Energy Conservation, Measures for Promoting Energy Conservation, Eco-Friendly Energy Sources, Energy Audit.

**Mineral Resources:** Metals and Non-Metals, Formation of Mineral Deposits, Consequences of over Exploitation and Conservation of Mineral resources of India and their Distribution.

### Unit III

**Water Resources:** Surface, Ground and Frozen Water, Desalination, Uses for Agriculture–Energy Generation–Domestic Consumption. Causes for Water Stress, Water Availability and its Demand. Dams–Types and Impacts–Alternatives. Water Conservation Strategies in India–Rain Water Harvesting. Marine Resources–Chemicals, Food and Energy.

### Unit IV

**Land & Forest Resources:** Agricultural Practices in India–Exploitation of Agricultural Land. Range Land Management. Minerals–Mining, Quarrying and their Impacts. Exploration of Oil and Natural Gas. Types of Soil Erosion, Detrimental Effects, Control Measures, Soil Conservation Practices, Soil Fertility and Soil Degradation.

Importance of Forestry, Forest Products, Forest-Based Medicinal and Pharmaceutical Industries. Forest Fire and its Control. Afforestation and Joint Forest Management – Social Forestry, Agro-Forestry. Forest Act- Salient Features.

### Books for Reference

01. **Environmental Ecology :** Gurudeep Raj, P.R.Trivedi, Akashdeep Publishing House, New Delhi.
02. **Forests in India :** V. P. Agrawal, Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi, (1968).
03. **Introduction to Social Forestry :** Sitram Rao, Oxford and IBH Pub. Co. Pvt. Ltd.
04. **An Introduction to Environmental Management :** Dr. Anand S. Bal, Himalaya Publishing House (2005).
05. **Energy Resources and Environment:** V.K. Prabhakar, Anmol Publisher
06. **Environmental Biology:** Biswarup Mukharjee by Tata McGraw Hill Publishing Company Ltd, New Delhi.
07. **Biomass Energy and Environment:** H.R. Ravindranath, Oxford University Press, New York. 1995.
08. **Non Conventional Energy Sources:** G.D. Rai, Khanna Publication, New Delhi
- 09 **Renewable Energy Sources and Emerging Technologies:** D.B. Kothari and K.C. Singal, PHI Learning Pvt. Ltd. New Delhi, 2011
10. **A Textbook of Environmental Studies:** Dr. Satyanaraya, Dr. S.R. Sitre, Dr. S.B. Zade, Dr. P.U. Meshram, Allied Publisher.

## Semester II

### Paper VII

#### Environmental Sampling and Research Methodology (2T3)

#### Unit I

**Air Sampling:** Objective and Criteria of Air Sampling, Selection of Sampling Location, Sampling Methods (Sedimentation, Filtration, Centrifugal and Impingement Method), Instrumental Techniques used in Estimation of Atmospheric Air Pollutant, Dust Fall Jar, SPM and RSPM using High Volume Air Sampler.

#### Unit II

**Water Sampling:** Necessity of Water Sampling, Objectives, Selection of Sampling Site, Types of Water Samples, Collection, Handling and Preservation, Sampling Equipment, Classification of Water Quality Parameters (Inorganic, Organic and Nutrient), Parameters analyzed on the Spot, (Field

Parameters) Data Interpretation, Basic Concept, Significance and Measurement of DO, BOD, COD, Phenol, Pesticides and Polynuclear Aromatic hydrocarbon (PAH) in Water and Wastewater.

### Unit III

**Soil and Solid Waste Sampling:** Objectives of Soil and Solid Waste Sampling, Site Selection Criteria, Collection and Handling of Soil and Solid Waste Samples, Preparation of Soil Samples for Analysis, Physico-Chemical Parameters and their Significance (Quality and Productivity).

### Unit IV

**Research Methodology & Errors in Environmental Analysis:** Introduction, Research Problem and Design, Data Collection, Data Representation, Measure of Central Tendency, Measure of Variation, Correlation and Regression, Testing of Hypothesis, Interpretation and Report Writing.

Nature of Errors, Types of Errors and Importance of Error, Random Error, Estimation of Standard Deviation, Confidence Limits of Analytical Results, Combined Effects of Different Random Errors, Comparison of Two Means, Comparison of Two Standard Deviations, Correction, Limit of Detection, Bias, Precision and Accuracy.

### Books for Reference

01. **Biostatistics** : P. N. Arora, P. K. Malhan, Himalaya publishing House, Delhi, 2008
02. **Basic concepts of Biostatistics** : N. Arumugam, Saras Publications, Kanyakumari, 2003
03. **Biostatistics in theory and Practice** : T. K. Saha, Emkay Publications, Delhi, 1992
04. **Biostatistics**: P. Ramakrishnan, Saras Publications, Kanyakumari, 1995
05. **Statistical Methods** : S. C. Gupta, S. Chand & Sons Publishers, New Delhi, 1997
06. **Evolution Biostatistics & Computer Applications** : A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003
07. **Fundamentals of Computer** : V. Rajaraman, Prentice Hall of India, New Delhi, 2008
08. **Computer Fundamentals** : Pradeep K. sinha, Preeti Sinha, BPB Publications, New Delhi, 2007
09. **Computer** : Malhar V. Lathkar, Sadhusudha Prakashan, Nanded, 1995
10. **Environmental Science Principles and Practices** : R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008

## Semester II

### Paper VIII

### Analytical Techniques for Environmental Monitoring (2T4)

#### Unit I

**Chromatography:** Definition of the Term Chromatography-Theory of Chromatographic Separation, Stationary and Mobile Phases, Classification of Chromatographic Separations. Gas Chromatographic Techniques–Instrumentation- Criteria for the Choice of Mobile and Stationary Phase. Detectors–Flame Ionization Detectors. (FID) Electron Capture Detectors (ECD) and Thermal Conductivity Detectors (TCD). Advantages of Gas Chromatography coupled with Mass Spectrometry (GC-MS).

**Liquid Chromatography:** Choice of Solvents and Stationary Phases- Characteristics of Various Stationary Phases in Chromatography, Thin Layer Chromatography and Paper Chromatography.

#### Unit II

**Absorption Spectrophotometry:** Principle, working and applications of various instruments like UV-Visible Spectrophotometer, Infra red (IR) Spectrophotometer, Nuclear Magnetic Resonance (NMR), Atomic Absorption Spectrophotometer (AAS), Flame Photometer, Conductivity Meter, Nephelometer/Turbidity Meter, pH Meter.

### Unit III

**Electro Chemical Techniques:** Introduction, Types of Electro Chemical Technique, Principle, Instrumentation and Application of Polarography in Environmental Chemical Analysis, Anodic Stripping, Voltametry with its Application in Environmental Measurements, Speciation of Heavy Metals like Copper, Cadmium, Mercury, Nickel & Arsenic in Natural Water System.

**Ion Selective Electrodes:** Basic Principles, Classification of Electrodes, Measurement Methods, Instrumentation and Application in the Analysis of Fluorides, Nitrates, Cyanides, Ammonia, Sulfides. Redox Potential Measurement and its Significance in Environmental Monitoring.

### Unit IV

**Modern Instrumental Techniques:** Atomic mass Spectrometry, Molecular Mass Spectrometry, Mass Spectrometric Applications in Environmental Analysis, Radiochemical Analysis, Inductively Coupled Plasma Spectroscopy (ICP), Aerosol Time of Flight Mass Spectrophotometry (ATOMFS).

#### Books for Reference

01. **Instrumental Methods of Environmental Analysis :** *Karan Sareen, ( Sarup ans Sons Publishers, New Delhi ), 2001*
02. **Instrumental Methods of Chemical Analysis :** *B. K. Sharma, Goel Publishing House, Meerut (1996).*
03. **Standard Methods for the Examination of Water and Waste Water:** *(APHA, AWWA & WPCF ), 1985*
04. **Instrumental Methods and Chemical Analysis :** *H. Kaur, Pragati Prakashan, Merrut (2009).*
05. **Instrumental Analysis :** *Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952*
06. **Instrumental Methods of Chemical Analysis :** *Chatwal and Anand (Himalaya Publishing House, New Delhi), 1994*
07. **Instrumental Analysis :** *Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000*
08. **Instrumental Methods :** *V. B. Borade (Nirali Prakashan, Mumbai)*
09. **Instrumental Analysis for Science and Technology :** *W. Ferren (Agrobios India, Jodhpur)*
10. **Photo chemistry & Spectroscopy:** *J.P. Simmons Wiley 1971*

## SEMESTER II PRACTICAL – III (2P1)

### Environmental Ecosystem And Management

1. To study the biotic components of a pond eco system.
2. To study a biotic components of a lake ecosystem.
3. To study different ecological indicators of an ecosystem
4. To study of forest ecosystem as biome, vegetation type characteristics and features of forest, soil type etc.
5. Collection and interpretation of wild life data with respective common spices, endanger spices rare spices
6. Determination of important value index (NI) of vegetation
7. To study of project tiger, project elephant, project crocodile in India with reference to conservation

### Natural Resources Management

1. Proximate analysis of coal for moisture volatile matter and carbon contain .
2. Study of calorific value of biomass .
3. Estimation of Chemical Oxygen Demand of waste water sample .
4. Estimation of Biochemical Oxygen Demand of waste water sample .
5. Analysis of biogas raw materials and out late effluents for efficiency .
6. Estimation soil for Organic Carbon, NPK,CEC and SAR.

## Semester II Practical IV (2P2)

### Industrial chemistry

1. Study of industrial processes of different industries .
2. Study of raw material used in industries and there environmental significances .
3. Study of characteristics of different waste form industries .
4. Study of preliminary treatment of waste water.
5. Study of chemical treatment of waste water.
6. Study of biological treatment of waste water.

### Analytical techniques

1. Study of principles components of U.V. visible spectrophotometer .
2. Analysis of sulphate by spectrophotometer.
3. Analysis of phosphate by spectrophotometer.
4. Analysis of nitrate by spectrophotometer.
5. Study of sodium, potassium, calcium and lithium by flame photo meter .
6. Demonstration of AAS for trace and heavy metal analysis.
7. Demonstration of HPLC and GC for pesticide analysis.

## Semester III Paper IX

### Physico- Chemical Treatment of Water & Waste Water (3T1)

#### Unit I

**Wastewater Sources:** Domestic and Industrial Wastes, Measurement of Wastewater Flow Rates with Respect to Channels and Pipelines, Direct Discharge through Velocity and Area Method.

**Quantity of Sanitary Sewage:** Sources of Sanitary Sewage, Factors Affecting Sanitary Sewage, Rate of Water Supply, Population Types of Area Served, Effect of Growth of Population, Determination of Quantity of Sanitary Sewage, Variation in the Quality of Sewage, Industrial sectors potential source of waste water generation, Industrial sectors generating polluted waste water.

#### Unit II

**Wastewater Collection:** Objectives of Wastewater Collection, Systems of Collection, Sewerage and Drainage System, Principle of Design for a Sewerage Scheme. Quantity of Sewage, Dry Weather Flow, Storm Water, Rational Method and Empirical Formulae for Determining the Quantity of Storm Water, Industry and waste water generation, Classification of industrial waste water based on its pollution load. Collection & transport of waste water from industry to effluent treatment plant or common effluent treatment plant.

**Wastewater Characteristic:** Types of Wastewater Discharge and Characteristic, Physico- chemical and Biological Characteristic of Sewage, Sewage Analysis, Difference in characteristics of waste water from various industrial sectors, Seasonal variation in industrial waste water generation.

**Relative Stability:** Population Equivalent, Estimation of Population Loads, Discharge Loads. Standards for Discharge of Treated Water into Rivers and on Land, Locations for Discharge of Wastewater in River/Sea Water

#### Unit III

**Classification of Wastewater Treatment Methods:** General Aspect, Objectives of Treatment, Location of Treatment Plant, Design Aspect, Mode of Treatment Based on Regulatory Guidelines, Physical, Chemical and Biological Methods, Unit Operations, Processes and Treatment Systems Used in Wastewater Treatment, Treatment Flow sheet, Plant Layout, Hydraulic Profile. Piping & Instrumentation ( P & I) diagram



#### Unit IV

**Physical Methods of Wastewater Treatment:** Theory & design principle of Screen, Grit Chamber, Oil & Grease Trap, Pre-Sedimentation, Pre-aeration, and Equalization, their Theory, Principles and Construction, Advantages and Disadvantages.

**Chemical Methods of Wastewater Treatment:** Introduction, Principle of Chemical Treatment, Unit Operations Involved in Chemical Treatment, Design Aspects. Methods of Treatment, Chemical Coagulation, Flocculation, Sedimentation, Filtration, Air Stripping, Ion Exchange Carbon Adsorption, Reverse Osmosis, Clarifiers, Efficiency of Chemical Precipitation.

#### Books for Reference

01. **Wastewater Treatment for Pollution Control** by Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi
02. **Water Supply & Sanitary Engineering** by R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.
03. **Wastewater Treatment** by M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
04. **A Textbook of Sanitary Engineering** by Vinayak Gharpure, Engineering Book Publishing Company, Pune.
05. **Water Pollution** by V. P. Kudesia, Pragati Prakashan, Meerut.
06. **Waste Water Engineering** by Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
07. **Waste Water Treatment- Concept & Design Approach** by G.L. Karia & R.A. Christian, Prentice Hall of India Press.
08. **Aquatic Plants for the Waste Water Treatment** : Alkarani Upadhaya ( Daya Publishing House, New Delhi )
09. **Introduction to Environmental Engineering** : Mackenzie L. Davis & David A. Cornwell ( Mc-Graw Hill Publishing Company, New Delhi )
10. **A Textbook of Environmental Chemistry & Pollution Control** : S S Dara, S. Chand & Company, New Delhi (2002).

### Semester III

#### Paper X

#### Biological Process in Wastewater Treatment (3T2)

##### Unit I

**Anaerobic Treatment:** Basic Principles of Anaerobic Treatment, Structure, Properties and Function of Biofilm, Types of Anaerobic Reactors and Processes – Thermophilic & Mesophilic reactors, Fixed Bed, Moving Bed, Expansion Bed, Fluidized Bed, Recycled Bed, Upflow Anaerobic Sludge Blanket Reactor (UASB), Continuous stirred tank reactor (CSTR). Design basics of UASB & CSTR Reactors.

**Anaerobic Digestion and Sludge Treatment:** Introduction to Anaerobic Digestion, Microbiology of Anaerobic Digestion, Reactor Configurations, Methane Production, Applications of Anaerobic Digestion, Composition, Characteristics and Methods of Sludge Disposal.

##### Unit II

**Aerobic Treatment** : Basic Principles, Design Consideration and Working of Aerobic Treatment Technologies - Aerated lagoon, Trickling Filters, Rotating Biological Contractor, Aerobic Biotowers.

**Activated Sludge Process:** Properties of Activated Sludge, Actions of Activated Sludge, Flow Diagram of Activated Sludge, Method of Aerations, Sludge Bulking, Sludge Volume Index, Sludge Density Index, Advantages and Disadvantages of Activated Sludge Process, Stabilization Pond and

Rotating Biological Contractor (RBC).

### Unit III

**Operation & Maintenance of Wastewater Treatment Plant:** Objectives of Operation of Wastewater Treatment Plant Units, Probable Trouble Shooting Parameters and their Control, Maintenance Procedures for various units & equipment such as Screens, Grit Chamber, Skimming Tanks, Primary clarifiers, aeration tanks, secondary clarifiers, Anaerobic digesters (Fixed Film, UASB & CSTR), Filters.

### Unit IV

**Waste water treatment & Reuse :** Concept of industrial waste water recycle & reuse. Treatment scheme, flow diagram & hydraulic profile for Sewage reuse plant, generation & utilization of methane from treatment of industrial waste water & sewage. Indian scenario of sewage generation & treatment, hurdles in sewage treatment, statutory guidelines for industrial waste water treatment & discharge, introduction to Zero Liquid Discharge (ZLD) & Common Effluent Treatment Plant (CETP).

### Books for Reference

01. **Waste water treatment for pollution control :** *Soli J. Arceivala (Tata Mc-Grew Hill Publishing Company, New Delhi)*
02. **Water supply and sanitary engineering :** *R. C. rangwala and S. C. rangwala (Charotal publishing house, Anand)*
03. **Waste water treatment :** *M. N. Rao, A. K. Datta (Oxford and IBH publishing company, New Delhi)*
04. **A Text book of Sanitary Engineering :** *Vinayak Gharpure (Engineering Book Publishing Company, Pune)*
05. **Water Pollution :** *V. P. Kudesia (Pragati Prakashan, Meerut)*
06. **Environmental Chemistry :** *B. K. Sharma (Goel Publishing House, Meerut)*
07. **Waste water Engineering :** *Metcalf and Eddy (Tata Mc-Grew Hill Publishing Company, New Delhi)*
08. **Environmental Chemistry :** *A. K. De (Wiley eastern limited, New Delhi)*
09. **Environmental Pollution :** *H. M. Dix (New York)*
10. **Environmental Chemistry :** *B. K. sharma and H. Kour (Villa Publication, Meerut)*

### Semester- III

#### Paper XI

#### (ELECTIVE – I)

#### Water and Water Treatment (3T3)

### Unit I

**Water Treatment Process:** Primary, Secondary and Tertiary, Theory, Mechanism and Significance of Aeration, Coagulation, Flocculation, Sedimentation, Filtration and Disinfection. Miscellaneous Treatment Methods, Removal of Taste and Odour, Standards for Quality of Treated Water.

**Water Treatment:** Objective of Water Treatment, Principles of Water Treatment, Unit Operation and Unit Processes, Different Water Treatment Flow Sheets, Physico-chemical and Bacteriological Parameters and their Role in Water Treatment.

### Unit II

#### Filtration and Disinfection



**Filtration:** Objectives of Filtration, Classification of Filters, Filter Media and its Characteristics, Operation and Backwashing of Filters, Design Features of Slow and Rapid Sand Filters, Operational Problems in Water Filters, Pressure Filters.

**Disinfection:** Necessity of Disinfection, Method of Disinfection, Theory of Disinfection, Residual Chlorine and its Determination, Chemicals Used for Disinfection of Treated Water, Application of Chlorine and its Compounds, Plain Chlorination, Prechlorination, Post chlorination, Super Chlorination, Double Chlorination, Break Point Chlorination, Role of Ozone and UV as a Disinfectant.

### Unit III

**Water Softening:** Necessity of Water Softening, Types of Hardness, Units of Hardness, Effects of Water Hardness, Equivalent of Calcium Carbonate Concept, Methods of Water Softening, (Lime, Soda Process, Zeolite Process, Demineralization Process, Ion Exchange Resins) and their Chemical Reactions, Occurrence of Iron and Manganese in Water, Objectives, Significance and Methods of Removal, Occurrence of Fluoride in Water, Need for Removal, Chemical Treatment of Defluoridation and Mechanism Health Effects, Methods of Defluoridation, Nalgonda Technique.

### Unit IV

**Modern Water Treatment Techniques:** Introduction, Removal of Colour, Odour and Taste, Aeration, Treatment With Activated Carbon, De-Salinisation of Brackish Waters, Distillation, Reverse Osmosis, Solar Distillation, Mineral Waters, Natural Mineral Water, Quality Requirement of Packaged Drinking Mineral Waters.

### Books for Reference

01. **Environmental Chemistry:** B. K. Sharma, Goel Publishing House, Meerut.
02. **Waste Water Engineering:** Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
03. **Environmental Chemistry:** A. K. De, Wiley Eastern Limited, New Delhi.
04. **Environmental Pollution:** H. M. Dix, New York.
05. **Environmental Chemistry:** B. K. Sharma and H. Kour by Villa Publication, Meerut.
06. **Introduction to Environmental Engineering:** Mackenzie L. Davis & David A. Cornwell, McGraw Hill Publishing Company, New Delhi.
07. **Basic Water Treatment:** George Smethurst, Scientific Publishers, Jodhpur.
08. **Chemical And Biological Methods For Water Pollution Studies:** R. K. Trivedy, P. K. Goel, Environmental Publication, Karad.
09. **Basic Water Treatment :** George Smethurst ( Scientific Publishers, Jodhpur )
10. **Water Pollution and disposal of Waste water on Land :** U. N. Mahida ( Tata Mc-Grew Hill Publishing Company, New Delhi

### Semester- III (ELECTIVE-II) Paper XII

### Water Supply and Resources (3T3)

#### Unit I

**Sources of Water Supply:** Importance and Necessity of Water Supply Scheme, Essential of Water Supply Scheme, Types of Water Sources, Surface Sources- General, Sources of Water, Streams, Lakes, Rivers, Ponds, Impounded Reservoirs, Stored Rainwater, Suitability of Surface Water with Regard to Quality and Quantity, Reservoir Storage Capacity.

## Unit II

**Surface & Ground Water Quality:** Infiltration, Porosity, Water Bearing Stratum, Groundwater flow, Groundwater Yield, Permeability, Groundwater Velocity, Springs, Infiltration Galleries, Porous Pipe Galleries', Classification of Wells, Dug Wells or Percolation Well, Yield & Types of Wells, Tube Wells, Specific Capacity of a Well, Infiltration Well, Artesian Well, Yield of a Artesian Well, Yield of an Infiltration Gallery. Parameters of Organic Content of Water Quality, DO and BOD, Transformation and Transport Process in Water Body, Oxygen Transfer by Interphase, Turbulence Mixing in River, Water Quality in Lakes and Rivers and Groundwater.

## Unit III

**Quantity and Quality of Water:** Types of Demand, Factor Affecting Rate of Demand, Variations in Rate of Demand, Measurement of Water Quantity, Effects of Variation on Design, Water Requirements for Buildings Other than Residences, Estimating Population, Factors Affecting Estimated Population, Meaning of Pure and Potable Water, Impurities in Water, Analysis of Water, Physical Tests, Chemical Test, Bacteriological Tests, and Maintenance for Purity of Water, Precaution and Preservation, Water Born Diseases.

## Unit IV

**Distribution of Water:** Method of Distribution System, Requirement of Distribution of Water and their Merits and Demerits, System of Supplying Water, Types of Service Reservoir, Different Layout for Distribution of Water, Design and Maintenance of Distribution System, Analysis of Pipe Network, Detection and Prevention of Leakages, Rectification, Types of Valves, Fire Hydrants, Water Meters

### Books for Reference

- 01. Instrumental Methods of Analysis :** *Willered Merit and Dean (CBS Publication, New Delhi)*
- 02. Wastewater Treatment for Pollution Control:** *Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi*
- 03. Water Supply & Sanitary Engineering:** *G.S. Birdie*
- 04. Textbook of Water Supply & Sanitary Engineering:** *S.K. Husain*
- 05. Water Supply & Sanitary Engineering:** *R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.*
- 06. Wastewater Treatment:** *M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.*
- 07. A Textbook of Sanitary Engineering:** *Vinayak Gharpure, Engineering Book Publishing Company, Pune.*
- 08. Water Pollution:** *V. P. Kudesia, Pragati Prakashan, Meerut.*
- 09. Environmental Problems and Solution:** *D.K. Asthana, S.Chand and Company, New Delhi.*
- 10. A Textbook of Environment:** *K. M. Agarwal and P.K. Sikdar, Macmillon India Ltd, Nagpur*

## Semester III

### Paper XIII

#### (Foundation-I)

#### Fundamentals of Environmental Science- I (3T4)

*(Student shall opt for this paper from any other subject other than his / her main subject for Post-graduation.)*

#### Unit – I:

- 1.1 Definition, and Scope of Environmental Science,
- 1.2 Man and Environment Relationship,
- 1.3 Types of Environment-Natural and Anthropogenic Environment,
- 1.4 Concept of Environmental Education – Formal and Non Formal,
- 1.5 Environmental Organizations and Agencies –National and International,

- 1.6 Classification of Total Environment- Segments of Environment and their Interactions with each other,
- 1.7 Environmental Calendar,
- 1.8 Activists in Environmental Movements and their role,
- 1.9 Institutions in environment
- 1.10 Necessity and awareness on Environmental Issues

#### **Unit – II:**

- 1.1 Atmosphere: Composition and Structure of Atmosphere, Lapse Rate and Temperature Inversion
- 1.2 Hydrosphere: Hydrological Cycle, Structure and Composition of Hydrosphere,
- 1.3 Evaporation, Condensation, Forms of Condensation-Mist, Fog, Clouds and Smog, Case Studies
- 1.4 Global Water Balance, Types of Water, Factors Influencing the Surface Water,
- 1.5 Ground Water Exploration, Rain Water Harvesting,
- 1.6 Lithosphere: Structure and Composition of Lithosphere,
- 1.7 Composition of Soil, Soil Formation: Factors Affecting the Soil Formation, Physico-Chemical and Biological Weathering, Soil Profile, Classification of Soil in India,
- 1.8 Properties of Soil, Soil Erosion, Types- Physical, Chemical and Biological Soil Erosion,
- 1.9 Conservation of Soil –Aims and Objective, Soil Degradation- Causes and Impacts,
- 1.10 Biosphere: Concept of Biosphere, Exosphere.

#### **Unit -III:**

- 1.1 Definition, Scope, Branches of Ecology,
- 1.2 Application and Significance, Ecological Landmark, Ecological Status in India.
- 1.3 Abiotic Environmental Factors- Temperature Light, Water, Humidity and
- 1.4 Biotic Environmental Factors
- 1.5 Concepts, Structure and Functions of Ecosystem
- 1.6 Types of Ecosystem, Fresh water Ecosystem –Lake Ecosystem, Forest and Grassland Ecosystem.
- 1.7 Dynamics of Ecosystem, Energy flow,
- 1.8 Food Chains, Food Web, Tropic Levels,
- 1.9 Biogeochemical Cycles (Carbon, Nitrogen, Phosphorus and Sulphur)
- 1.10 Basic Concept of Productivity, Productivity of Different Ecosystem

#### **Unit -IV:**

- 1.1 Concept, Definition, Diversity of Wildlife,
- 1.2 Importance of Wildlife, Examples of Protected Wildlife Species.
- 1.3 Wildlife in India.
- 1.4 Endangered Flora and Fauna in India.
- 1.5 Categories of Threatened Species- Rare, Endangered, Vulnerable, Extinct, Species in Wildlife of India.
- 1.6 National Park, Wildlife Sanctuaries, Biosphere Reserve.
- 1.7 Habitat Preservation, Ex-Situ and In-Situ Conservation.
- 1.8 Wildlife Protection Act 1972.
- 1.9 Threats to Wildlife, Habitat Destruction,
- 1.10 Developmental Projects Project Tiger, Project Elephant,

#### **Books for Reference**

1. **Fundamentals of Ecology** – *E.P. Odum, Revised Edition 1995-96*
2. **Principles of Ecology** – *P.S. Verma, V.K. Agarwal, S. Chand and Co. Delhi.*
3. **Principles of Environmental Science** – *Wart K.E.F. 1973, Mc Graw Hill Book Company.*
4. **Ecology** – *M.P. Arora*
5. **Basic Ecology** – *E.P. Odum*
6. **Concept of Ecology** – *E.J. Koromondy, 1996, concept of modern biology series, prentice Hall.*
7. **Modern Concepts of Ecology** – *H.D. Kumar*
9. **Environmental Biology** – *P.D. Sharma, Rastogi Publication, Meerut.*
10. **Ecology and Environment** - *P.D. Sharma, Rastogi Publication, Meerut.*

11. **Basic concepts of soil science** – A.K. Kolay, Willey estern ltd., New Delhi.
12. **Environmental Science** – Enger, Smith, Smith, W.M.C. Brown company publishing
13. **Fundamental of Ecology** – Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.
14. **Concepts of Ecology (Fourth Edition)**- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
15. **Environment forest, ecology and man** – Dixit R.K. Rastogi Publication, New Delhi.
16. **Physical geography** – Dasgupta
17. **Environment, energy, health planning for conservation** – V. Vidyanath, Gyan Publishing House, New Delhi.
18. **Environmental Chemistry** - B. K. Sharma & H. Kaur , Goel Publishing House, Meerut
19. **Industrial Chemistry**- B. K. Sharma, Goel Publishing House, Meerut
20. **Environmental Chemistry**- A. K. Dey, Wiley Eastern Ltd, 1987.
21. **A Text book of Environmental Chemistry**-O.D.Tyagi, M.Mehra, Anand Publications Pvt, Ltd, 1994.
22. **Elements of Environmental Chemistry**-H. V. Jadhav, Himalaya Publishing House, 1992.

### Semester III

#### Paper XIV

#### Core (Subject Centric) 1

#### Advanced Water & Waste Water Treatment (3T4)

*(Candidate can opt for this paper in their main subject of Post graduation ONLY).*

#### Unit I:

**Introduction to advanced treatment in water and waste water:** Need of advance treatment, Present Indian & Global Scenario, Concept and need of Zero Liquid Discharge, Drinking water parameters , discharge norms for waste water, treatment technology up gradation as per discharge guidelines, Concept of CETP, advantages and disadvantages, case studies of performance of CETPs.

#### Unit II:

**Advancement in Water Treatment:** Introduction, concept of membrane technology in water treatment, Modern Desalination plants and its operations, treatment technology and operations of packaged drinking water and mineral water plants, Dual Media Filtration, advancement in Reverse Osmosis Technology for drinking water, reducing contaminants through RO, RO Process, Design of an RO system, RO membrane materials , Maintenance and efficiency of an RO system.

#### Unit III

**Advancement in Waste Water Treatment :** Operation of Dissolved Air Floatation Unit (DAF), Design basics of High Rate Solid Contact Clarifier (HRSCC) , removal of silica, hardness and heavy metals from waste water, Membrane Bio Reactor (MBR), Moving Bed Biofilm Reactor ( MBBR), Automation in waste water treatment plant and its advantages.

#### Unit IV

**Cost Economics of Modern Technologies:** Concept of cost economics of treatment philosophy. Reverse osmosis a tool for water sustainability, Nano Filtration, Multi Effect evaporators, recycling & reuse of treated sewage, Biogas generation and it's reuse, cost economics of RO Plants and STPs. Decentralized Sewage treatment plant and it's cost economics.

#### Books for Reference

1. **Waste Water Engineering:** Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
2. **Introduction to Environmental Engineering:** Mackenzie L. Davis & David A. Cornwell, McGraw Hill Publishing Company, New Delhi.

3. **Basic Water Treatment** : George Smethurst ( *Scientific Publishers, Jodhpur* )
4. **Wastewater Treatment for Pollution Control** by Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi
5. **Water Supply & Sanitary Engineering** by R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.
6. **Wastewater Treatment** by M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
7. **Waste Water Treatment- Concept & Design Approach** by G.L. Karia & R.A. Christian, Prentice Hall of India Press
8. **Introduction to Environmental Engineering** : Mackenzie L. Davis & David A. Cornwell ( *Mc-Grew Hill Publishing Company, New Delhi* )

### **SEMESTER III**

#### **Practical -V**

#### **Physico- Chemical Treatment of water & Waste Water and Biological Process in Waste Water Treatment (3P1)**

1. Relative density test for a sample of waste water.
2. Determination of Sludge Volume Index (SVI) of sludge samples.
3. Determination of Sludge Density Index (SDI) of sludge samples.
4. Estimation of Nitrogen by Kjeldahl's methods.
5. Estimation of Phosphate and Sulphate in sludge for fertilities values
6. Estimation of Chemical Oxygen Demands (COD) of waste water
7. Estimation of Biochemical Oxygen Demands (BOD) of waste water
8. Determination of percent organic matter of a sludge
9. Study of sludge for its composition (solids, suspended volatile fixed and total)
10. Estimation of suspended ,dissolves ,total, volatiles solids in sewages.
11. Study of sewage treatment plant with respect to :
  - A. Flow measurement
  - B. Design of screen, grit chamber, aeration tank, anaerobic digesters, settling units and filtration unit.

#### **Visit to:**

- a. Sewage Treatment Plant
- b. Industrial Waste water treatment plant

#### **Case Studies:**

- a. Submission of case study of Sewage Treatment Plant & Industrial waste water treatment plant.

### **Semester III**

#### **Practical – ELECTIVE – I (3P2)**

#### **Water & Water Treatment:**

1. Determination of impurities of water viz. color , temp., odour and taste of water
2. Determination of total solids in water (suspended & dissolved).
3. Determination of iron and manganese by spectrophotometer.
4. Determination of hardness in raw and treated water.
5. Determination of chloride in water samples by argentometric method
6. To conduct chlorine demand test of a sample of water and to draw chlorine demand curve to determine brake point chlorination.
7. Determination of optimum coagulant dose by jar test apparatus.

**Visit to:** Water Treatment Plant

**Case Study:** Submission of case study of water treatment plant highlighting the need, performance & operation.

**Semester III**  
**Practical – ELECTIVE – II (3P2)**

**Water Supply and Resources:**

1. Determination of turbidity of the sample by turbidity meter.
2. Determination of optimum coagulant dose by jar test apparatus.
3. Determination of fluoride by SPADNS methods / Ions selective Electrodes.
4. Determination langelier calcium carbonate saturation Index.
5. To conduct chlorine demand test of a sample of water and to draw chlorine demand curve to determine brake point chlorination.
6. Determination of alum doses for defluoridation of water using Nalgonda techniques.
7. Preparation of different models for rain water harvesting.

**Visit to:** Water Supply Schemes

**Case Study:** Submission of case study of water supply scheme highlighting the need, performance & operation.

**Semester IV**  
**Paper XV**  
**Air and Noise Pollution Control Technology (4T1)**

**Unit I**

**Atmosphere & Air Pollution:** Origin and Composition of Atmosphere, Structure of Atmosphere, Atmospheric Photochemical Reactions, Reactions of Nitrogen Oxides in Urban Atmosphere, Reactions of Hydrocarbons in Urban Atmosphere.

Definition of Air Pollution, Classification of Air Pollutants and their Sources, Acid Rain, Photochemical Smog, Effects of Air Pollutants on Man, Animals, Plants and Materials, Air Pollution episodes and Air Pollution Control Measures. Standards Prescribed for Air Quality in India. Air Pollution Index, Types and Uses.

**Unit II**

**Air Sampling & Monitoring:** Criteria, Selection of Sampling Locations, Analytical and Instrumental Techniques Used in Estimation of Atmospheric Pollutants (Particulate Matter and Gases), Stack Sampling, Considerations Sampling, Point Selection for Circular and Rectangular Ducts, Sources Sampling Equipments for Gases and Particulars, Methodology of Measurement of SO<sub>2</sub>, NO and Dust. Collection of Particulates, High Volume Sampler, Sampling Methods for determination of Sulphation Rate, Sulphur Dioxide, Oxides of Nitrogen, Carbon Monoxide, Hydrocarbons, and Volatile Organic Carbons (VOC), Ozone, Air Quality Standards and Index (National and Euro standards).

**Unit III**

**Industrial Air Emission Control:** Introduction, Characterizing the Air Stream, Equipment Selection, Principle & Design—Condensation, Absorption, Adsorption, Filtration, Impingement Separator, Scrubbers, Electrostatic Precipitator, Fabric Filters, Cyclones Collector, Gravity Settling Chamber. Flue Gas Desulfurization, NO<sub>2</sub> removal, Fugitive Emissions, Role of Green Belts.



#### Unit IV

**Noise Pollution:** Basic Properties of Sound, Sound Pressure and Intensity Levels, Equivalent Sound Pressure Levels (leq), Noise Pollution Levels (npl), Sound Exposure Levels (sel) Measurement of Noise, Decibel Scale, Sources of Noise Pollution, Physiological and Psychological effects of Noise Pollution, Noise Control Criteria, Equipment used for Noise Measurement, Control Measures of Noise Pollutions, Noise Control and Abatement Measures, Sound Absorbing Materials, Acoustic Silencers, Mufflers, Barriers, Vibrations and Impact Isolation. Permissible exposure Limits, Noise Pollution Control in Industries, Standards Prescribed for Noise in Indian Context.

#### Books for Reference

01. **Air Pollution and its control** : Sumit Malhotra ( Pointer publishers, Jaipur )
02. **Air Pollution** : M. N. Rao ( Tata McGraw – Hill publishing company, New Delhi)
03. **Air Pollution** : B. K. Sharma, H. Kaur ( Krishna prakashan media, Meerut )
04. **Pollution of our Atmosphere** : B. Henderson, ( Sellers Adam Hilger Limited, Bristol )
05. **Fundamentals of Air Pollution** : Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern ( Academic Press, California)
06. **Air Pollution control Engineering** : Noel De Nevers ( Mc Graw – Hill international, New York )
07. **Air Pollution** : S. K. Agarawal ( A. P. H. Publishing corporation, New Delhi )
08. **Air Pollution** : V. P. Kudesia ( Pragati Prakashan, Meerut )
09. **Noise Pollution and Control Strategy**: S.P. Singal, Narosa Publishing House, New Delhi.
10. **Noise Pollution**: B. K. Sharma, H. Kaur, Goel Publishing House, Meerut, 1994.

#### Semester IV Paper XVI

#### Solid and Hazardous Waste Management (4T2)

##### Unit I

**Nature of Solid Waste:** Introduction, Classification and Origin of Solid Waste, Characteristic of Solid Waste, Methods of Solid Waste Treatment and Disposal, Pyrolysis, Recycling and Reuse of Solid Waste and Management, Solid Waste Handling Methods, Segregation and Salvage, Recovery of the Bio Products, Public Health Aspect Related to Solid Waste, Status of Municipal Solid Waste in India.

##### Unit II

**Solid Waste Management:** Introduction, Vermiculture, Composting, Biogas from MSW, Land Fill (Site Selection, Site Investigation and Site Characterization), Landfill Planning and Designing, Construction and Operational Practices, Landfill Quality and Control, Indian Scenario and Legislative Control, modern technologies for solid waste treatment - Mass Burn Technology, case studies, Municipal Solid Waste (Management and Handling Rules 2000).

##### Unit III

**Hazardous Waste:** Definition, Classification, Identification, Sources and Characteristics of Hazardous Waste, Integrated Approach for Minimization of Air, Water and Solid Pollutants, Collection, Storage, Transportation, Hazardous Waste Testing in Terms of Toxicity, Corrosively, Ignitability and Reactivity, Priority Pollutants, Acute and Chronic Toxicity, Bioaccumulation, Mutagenicity, Teratogenicity Carcinogenicity and Genotoxicity.

##### Unit IV

**Hazardous Waste Treatment & Management:** Physico-Chemical, Biological and Thermal Destruction of Hazardous Wastes, Incineration, Pyrolysis, Wet Air Oxidation, Containment Technologies, Secured Landfill, Land Farming, Bioremediation, Biodegradation of Recalcitrant, Xenobiotics Treatment. Guidelines for Identification of Landfill for Hazardous Waste Disposal. Hazardous Waste Treatment Facility- Planning of Hazardous Waste Incinerator & Inorganic Waste Treatment Plant, Leachate Management. Waste Minimization, Recycle and Reuse of Hazardous Waste, Recovery of Chemicals from Hazardous Wastes, Management and Handling Rules, India-1989. Categories of Biomedical Waste, Contaminated Site Remediation- *Ex-Situ* and *In-Situ* Approach, Landmark Episodes.

### Books for Reference

01. **Solid waste pollution** : *Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008*
02. **Principals of Soil Science** : *M. M. Rai, McMillon Publication.*
03. **Soil pollution & Soil organisms** : *P. C. Mishra*
04. **Environmental Chemistry** : *B. K. Sharma, Goyal Publishing House, Meerut, U.P. 1984*
05. **Environmental Science** : *S. C. Santra, New Central Book Agency, Kolkata, 2005*
06. **Environmental Pollution Control Engineering:** *C. S. Rao, New age International, Mumbai, 2003*
07. **Fundamentals of Soil Science** : *Henry D. Foth, John Wiley & Sons, New York, 1984*
08. **Environmental Engineering** : *Davis & Cornwell, McGraw – Hill Publications, New York, 1998*
09. **Environmental Science Principles and Practices** : *R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008*
10. **Basic Environmental Technology:** *Jerry A. Nathanson, Prentice Hall of India Ltd. New Delhi, 2004*

### Semester IV (ELECTIVE-I) Paper XVII

### Environmental Impact Assessment and Legislation (4T3)

#### Unit I

**Environmental Impact Assessment:** Definition, Basic Concepts and Principles of EIA. Nexus between Development and Environment, Need for EIA, Elements of EIA, Environmental Attributes, Nature of Impacts- Primary, Secondary, Tertiary, Short Term, Long Term, Reversible and Irreversible Impacts, Overview of Impacts, Directly and Indirectly Measurable Impacts of Air, Noise, Water, Land, Biological and Socio-Economic Elements.

#### Unit II

**EIA Procedure:** Screening and Scoping in EIA, Methodologies of EIA, Checklist, Matrices, Overlays, Cost Benefit Analysis, Computer Aided EIA, Battelle Environmental Evaluation System-Impact Identification Networks, Strategies for Environmental Management Plan and Green Belt Development, Role of Mathematical Models in EIA. Environmental Appraisal of Project with Reference to Industry, Mining and water Resources projects-Critical Issues and Formulation of Strategies for EMP, Strategic Environmental Impact Assessment, Methods, Benefits, Legislation of EIA in India and Modification, Role of Statutory Agencies in EIA Clearance.

#### Unit III

**Environmental Audit and EMS:** Definition, Concept of EA, Types of EA, Benefits of Environmental Audits, Scope and Objectives, Procedural Requirements of Conducting EA, Pre-Audit, on-Site Audit and Post Audit Activities, Water Audit, Raw' Materials Audit and Energy Audit, Health and Safety Audit -Reuse and Conservation of Water and Energy, Waste Minimization, Environmental



and Economic Benefits of An Environmental Audit, ECO- Audit and its Importance in Environmental Management, Concept of ISO 9000 and ISO 14000 in Environmental System Management

#### **Unit IV**

**Environmental Legislation:** Constitutional and Statutory Laws in India, Fundamental Duties and Fundamental Rights, Legal Control of Environmental Pollution With

Reference to: The Water Prevention and Control of Pollution Act 1974

The Air Prevention and Control of Pollution Act 1981

The Environmental Protection Act 1986

The Wild Life (Protection) Act 1972

The Wild life Protection Rules 1995

The Indian Forest Act 1927

The Forest Conservation Act 1980

The Forest Conservations Rules 1981

Salient Features of Coastal Zone Regulations (CZR) Notification, the Convention of Biodiversity. (Several Case Studies to be given as Assignment).

#### **Books for Reference**

- 01. Environmental Impact Assessment :** *Principles and Procedures, John Wiley and Sons, New York.*
- 02. Environmental Impact Assessment :** *A.K.Shrivastav, APH Publishing Corporation, New Delhi.*
- 03. Environmental Impact Assessment :** *S.A.Abbasi, D.S.Arya, Discovery Publishing House, New Delhi.*
- 04. Environmental Pollution Control :** *Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation, New Delhi, 2005*
- 05. Environment Problems and Solutions :** *D.K.Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi.*
- 06. An Introduction to Environmental Management :** *Dr.Anand S.Bal, Himalaya Publishing House, New Delhi.*
- 07. Environmental Impact Analysis Handbook :** *John G.R. and David C.Wooten, McGraw Hill Publications, 1987*
- 08. Encyclopedia of Ecology and Environment :** *Environmental Impact Assessment Vol. 7 : By Trivedi P.R., Indian Institute of Ecology and Environment, New Delhi, 1999*
- 09. Environmental Law and Policy in India :** *Divan S and Rosencraz A, Oxford University Press, New Delhi, 2001*
- 10. Environmental Laws of India - An Introduction :** *CPR Environmental Education Centre, Chennai, 2001.*

#### **Semester IV (ELECTIVE-II) Paper XVIII**

#### **Environmental Management (4T3)**

#### **Unit I**

**Ecosystem Management:** Ecosystem Management, Exploitation (Overuse and Misuse) and its Consequences for the Ecosystem, Sustainable Management of Ecosystems, Management of Biodiversity (In-situ and Ex-situ Conservation), Habitat management, Species Conservations, Prevention of Extinction.

**Wildlife Management:** National Parks and Wildlife Sanctuaries, Integrated Protected Area Systems, Mitigation of People-Wildlife conflicts.

**Water and Soil Management:** Water as a Resource, Traditional Water Harvesting Systems, Management of Riverine Systems, Wetland Management and Conservation, Soil as a Resource, Consequences of Soil Degradation, Process of Soil Degradation, Assessment of Soil Erosion, Soil Conservation Measures, Afforestation.

## Unit II

**Computer Programming:** Computer Organization, Computer Generation and Classifications, Structure, Function, Capabilities and Limitations of Computers, Operating System, MS-Office, Development of Different Environmental Models by Simple Computer Programming. Internet access to Generate the Environmental Data.

**Remote Sensing and GIS:** Definition, Principles and Scope of Remote Sensing, Electromagnetic Radiation, Sensors and Type of Scanning Systems, Basic Characteristics of Sensors; Salient Features of Sensors Used in LANDSAT, SPOT and Indian Remote Sensing Satellites. GIS Technology and Its Uses in Environmental Science,

**Application of GIS:** In Agriculture, Environmental Management and Land Use, Land Cover. GPS (Global Positioning System): Basic Concepts, GPS Positioning Techniques, GPS Procedures, Role of GPS in GIS and Remote Sensing

## Unit III

**Environmental Geoscience:** The Earth Systems and Biosphere, Conservation of Matter in Various Segments Atmosphere, Hydrosphere, Lithosphere and Biosphere, Energy Budget of the Earth, General Relationship Between Landscape, Biomass and Climate, Climates of India, Droughts, Cyclones and Disturbance.

**Earth Process and Hazards:** Catastrophic Geological Hazards, Study of Floods, Land Slides, Earthquakes, Volcanism, Tsunami and Avalanche. Study of Topographic and Environmental Maps.

## Unit IV

**Current Issues and Environmental Problems:** Environmental Education and Awareness, Narmada Dam, Tehri Dam, Almatti Dam, Waste lands and their Reclamation, Water Crises-Conservation of Water, Eutrophication and Restoration of Indian Lakes, Scheme of Labeling of Environmentally Friendly Products (Eco Mark), Stockholm Conferences, Copenhagen Conference, Durban Conference and Worldwide Environmental Issues, Role of NGO in Environmental Management, Concept and Strategies of Sustainable Development, Cost Benefit Analysis, Environmental Priorities in India.

### Books for Reference

- 01. Fundamentals of Remote Sensing:** *George Joseph, Universities Press Hyderabad, 2005*
- 02. Remote Sensing and GIS :** *M. Anji Reddy, BS Publications, Hyderabad, 2008*
- 03. Remote Sensing Techniques in Agriculture :** *D. D. Sahu, R. M. Solanki, Agrobios India, Jodhpur, 2008*
- 04. GIS Basics :** *Shahab Fazal, New Age International Publishers, New Delhi, 2008*
- 05. Geographical Information Systems :** *Anil K. Jamwal, Jnanda Prakashan, New Delhi, 2008*
- 06. Environmental Science :** *S. C. Santra, New Central Book Agency, Kolkata, 2005*
- 07. A Text Book of Environmental Science :** *Purohit, Shammi, Agrawal, Student Edition, Jodhpur, 2004*
- 08. Environmental Science Principles and Practices :** *R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008*
- 09. Environmental Ecology :** *Gurudeep Raj, P.R.Trivedi, Akashdeep Publishing House, New Delhi.*
- 10. Forests in India :** *V. P. Agrawal, Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi, 1968.*

**Semester IV**  
**(Foundation-II)**  
**Paper XIX**

**Fundamentals of Environmental Science- II (4T4)**

*(Student shall opt for this paper from any other subject other than his / her main subject for Post-graduation.)*

**Unit -I:**

- 1.1 Definition of Air Pollution,
- 1.2 Classification of Air Pollutants and their Sources (Natural and Anthropogenic),
- 1.3 Effects of Air Pollutants on Man, Animals, Plants and Materials,
- 1.4 Air Pollution Control Measures, Taj Trapezium Zone (TTZ),
- 1.5 Standards Prescribed for Air Quality in India, Air Pollution Control Act,
- 1.6 Air Pollution Index and Air Pollution Episodes (Bhopal Gas Tragedy),
- 1.7 Acid rain-Sources, Effects and Chemical Reaction, Control Measures,
- 1.8 Sources and Effects of Green House Gases- O<sub>3</sub>, H<sub>2</sub>O, NH<sub>3</sub>, N<sub>2</sub>, NO, NO<sub>2</sub>, NO<sub>3</sub>, CH<sub>4</sub> and CFCs,
- 1.9 Climate Change and Global Warming,
- 1.10 Atmospheric Ozone, Mechanism of Ozone Depletion, Effects of Ozone Depletion.

**Unit – II:**

- 1.1 Introduction of Noise Pollution, Definition of Noise Pollution
- 1.2 Basic Properties of Sound, Sound Pressure and Intensity Levels,
- 1.3 Equivalent Sound Pressure Levels (leq), Noise Pollution Levels (npl), Sound Exposure Levels (sel)
- 1.4 Measurement of Noise, Decibel Scale,
- 1.5 Sources of Noise Pollution, Physiological and Psychological effects of Noise Pollution,
- 1.6 Noise Control Criteria, Equipment used for Noise Measurement,
- 1.7 Control Measures of Noise Pollutions, Noise Control and Abatement Measures,
- 1.8 Sound Absorbing Materials, Acoustic Silencers, Mufflers, Barriers, Vibrations and Impact Isolation.
- 1.9 Permissible exposure Limits, Noise Pollution Control in Industries,
- 1.10 Standards Prescribed for Noise in Indian Context.

**Unit – III:**

- 1.1 Definition of Water Pollution, Classification Water Pollutants and their Adverse Effects,
- 1.2 Sources of Water Pollution From Urban, Industrial, Agricultural and Natural Waters,
- 1.3 Interaction in Aquatic System, Nature of Sources-Stationary, Intermittent, Continuous and Mobile,
- 1.4 Bioaccumulation, Bio-Magnification and Eutrophication,
- 1.5 Water Borne Diseases,
- 1.6 Water Sampling, Selection of sampling site, collection,
- 1.7 Handling, preservation of samples, Types of water samples,
- 1.8 Physico-Chemical Characteristics of Water Quality,
- 1.9 Water Quality Criteria for Drinking Purpose
- 1.10 Water pollution Control Act

**Unit – IV:**

- 1.1 Soil Pollution, Soil Pollutants, Causes and Effects of Soil Pollution,
- 1.2 Major Sources of Soil Pollution,
- 1.3 Nutrients in Soil (NPK); Domestic, Municipal, Industrial and Agricultural Wastes and their Role in Soil Degradation,
- 1.4 Introduction of Solid Waste,
- 1.5 Classification and Origin of Solid Waste, Characteristics of Solid Waste,
- 1.6 Methods of Solid Waste Treatment and Disposal, Pyrolysis, Recycling and Reuse of Solid Waste Management, Solid Waste Pollution Scenario in India,

- 1.7 Land Fill (Site Selection, Site Investigation and Site Characterization),
- 1.8 Hazardous Waste, Hazardous Waste Testing in Terms of Toxicity, Corrosivity, Ignitability and Reactivity,
- 1.9 Priority Pollutants, Acute and Chronic Toxicity, Bioaccumulation, Mutagenicity, Teratogenicity Carcinogenicity and Genotoxicity.
- 1.10 Biomedical Waste, Categorization of Biomedical Waste and disposal practices in urban area

#### **Books for Reference**

- 01. Air Pollution and its control:** *Sumit Malhotra ( Pointer Publishers, Jaipur )*
- 02. Air Pollution:** *M. N. Rao ( Tata McGraw – Hill Publishing Company, New Delhi)*
- 03. Air Pollution:** *B. K. Sharma, H. Kaur ( Krishna Prakashan media, Meerut )*
- 04. Pollution of our Atmosphere:** *B. Henderson, ( Sellers Adam Hilger Limited, Bristol )*
- 05. Fundamentals of Air Pollution:** *Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern (Academic Press, California)*
- 06. Air Pollution:** *S. K. Agarawal ( A. P. H. Publishing corporation, New Delhi )*
- 07. Air Pollution:** *V. P. Kudesia ( Pragati Prakashan, Meerut )*
- 08. Noise Pollution and Control Strategy:** *S.P. Singal, Narosa Publishing House, New Delhi.*
- 09. Noise Pollution:** *B. K. Sharma, H. Kaur, Goel Publishing House, Meerut, 1994.*
- 10. Environmental Engineering:** *Gerard Kiely, Vol. I, II, & III Liptak, Tata McGraw Hill, New Delhi.(1998)*
- 11. Environmental Chemistry:** *A.K. De,. 2nd edn., 1990, Wiley Eastern Ltd., New Delhi.*
- 12. Industrial Pollution Control:** *Nancy J. Sell, , John Willey and Sons, Inc., New York (1992)*
- 13. A Text Book of Environmental Chemistry and Pollution Control:** *S.S. Dara, S. Chand, and Co. Ltd., New Delhi. (1995)*
- 14. Solid Waste Management in Developed Countries:** *A. D. Bhide and B.B. Sundersen, INSDOC, New Delhi (1983)*
- 15. A Book on Waste Management:** *Sinha R. K., Sinha A. K., Saxena V. S., INA, Shri publishers, Jaipur (2000)*
- 16. Solid waste pollution:** *Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008*
- 17. Soil pollution and soil organism:** *P.C. Mishra*

#### **Semester IV**

#### **Paper XX**

#### **Core (Subject Centric) -II**

#### **Disaster Management (4T4)**

*(Candidate can opt for this paper in their main subject of Post graduation ONLY).*

#### **Unit I:**

Disasters: Meaning, difference between disaster and hazard, causal factors. Disaster management cycle. Man- Made Disasters, types, nature of man-made disasters, general effects, concerns for manmade disasters. Biological disasters: meaning, types, vulnerability, effects, preparedness and mitigation. Chemical Disasters: Causes and impacts, chemical disaster management, mitigation, preparedness and response.

#### **Unit II:**

Nuclear disaster: causes, effects, management. Fires-I: Characteristics of fires; Building, coal, and chemical fires; causes; safety and prevention, safety norms and disaster management. Forest fires, their types, causes, impacts, mitigation and control. Desertification: Causes, general characteristics and effects & mitigation measures. Transportation Accidents: types, causes , impacts and disaster management.

#### **Unit -III**

Natural disasters: introduction, meaning and nature, types of natural disasters, general effects.

Earthquake: General characteristics, vulnerability, causes, impacts related to earthquakes, prediction, warning and mitigation measures. Volcanic eruptions: Nature and causes, volcanic hazard monitoring, mitigation. Landslides: General characteristics, Causes, vulnerability, effects, prediction & warning, risk reduction mitigation measures. Snow Avalanches: Avalanches formation and classification, hazard mitigation and management. Cyclone: Formation, General characteristics, vulnerability, effects, Forecasting & warning, mitigation measures. Floods: General characteristics, vulnerability Causes and impacts, forecasts & warning, Flood Plain zonation, mitigation measures. Drought: Meaning, types, General characteristics, Causes and impacts, vulnerability, prediction & warning and mitigation measures. Heat and Cold Waves: introduction causes and impacts, prevention and preparedness, Response. Tsunami: General characteristics, causes, impacts and mitigation.

#### **Unit IV:**

Disaster Response: Disaster response plans, Search, Rescue and evacuation, Community Health and Casualty Management and damage assessment. Risk and Vulnerability assessment: Risk, Vulnerability, their concepts, elements at risk, Risk analysis techniques, vulnerability identification and factors associated with vulnerability. Disaster preparedness: Concept and nature, Disaster preparedness plans, Role of Information, education, communication, & awareness. Disaster mitigation: Concept, principles, mitigation approaches and strategies.

Recovery: Rehabilitation, its social and economic aspects, Housing to resist disasters, relocation, retrofitting, repairing and strengthening of houses.

#### **Books for References:**

1. **Textbook of Environmental studies by Benny Joseph** , McGrew-Hill Publishing Company Limited
2. **Disaster Management by Mukesh Dhunna** , Vayu education of India, New Delhi, 2009 First edition
3. **Introduction to Environmental Science** by G. Tyler Miller, Jr. Scott Spoolman, cengage learning publication.
4. **Environmental Science by S.C. Santra**, New Central Book agency Pvt. Ltd. Kolkata , India
5. **Environmental Management** by H.P. Behera and M.S. Khan, Himalaya Publication
6. **Disaster Management Programmes And Policies** by Siddhartha Gautam K Leelakrishna Rao ,Publication - Vista International
7. **Introduction To Disaster Management** ,by Bc Bose 46 ,Rajat Publishers
8. **Global Disaster Management** ,by Arun Kumar,SBS Publishers
9. **Handbook Of Disaster Management (2 Vol.set)** , Author : Reepunjaya Singh ,ABD Publishers
10. **Environmental Impact Assessment(eia) And Disaster Management** , Author : Alok Satsangi ,Publisher : Rajat publication
11. **Disaster Plan and recovery A guide for facility process** Levitt and Alan M. John Wiley & Sons Inc, 1997
12. **Handbook of Disaster Management** Willium L. Waugh 2005
13. **Disaster Management : Text and Case Studies** D.B.N. Murthy Jain Book Agency 200
14. **Disaster Management and Risk Reduction: Role of Environmental Knowledge** Anil K. Gupta, Sreeja S. Nair, Florian Bemmerlein Lux and Sandhya Chatterji Jain Book Agency, 2013
15. **Disaster Management and Preparedness** Nidhi Gaubha Dhawan CBS Publishers and Distributors

**Semester IV**  
**Practical - VII (4P1)**

**A) Air and Noise Pollution Control Technologies**

1. Determination of Suspended Particulate Matter (SPM) and RSPM in ambient air by using High Volume Sampler.
2. Comparative analysis air sampling from residential, commercial, and industrial zone using key parameters like SO<sub>x</sub> and NO<sub>x</sub>.
3. Measurement of noise pollution by noise meter in silent, residential, commercial, and industrial zone and comparison with standards.
4. Determination of carbon monoxide in ambient air.
5. Preparation and interpretation of wind roses.
6. Estimation of poly aromatic hydrocarbons in air

**B) Solid and Hazardous Waste Management**

1. Determination of volatiles matter from solid waste sample.
2. Estimation of non volatiles matter form solid waste sample.
3. Study of calorific value of solid waste sample.
4. Study of moisture content of solid waste sample.
5. Study of bio medical waste generation and disposal practices in urban area.

**C) Environmental Impact Assessment and Legislation & Environmental Management**

1. Study of natural environment of the area with respect to soil, air, water ,noise and socio-Economics.
2. Study of environmental impact of the industries on water, air, soil and noise quality.
3. Study and undertake preliminary survey to identify impact on environmental parameters.
4. Base line Study of investigation of water, air, soil and noise quality of the area.
5. Study EIA legislation for environmental protection.
6. Study of environmental management practices in industries.

**Visit To:**

- a. Industries implemented ISO 14000
- b. NGO working in the field of environmental management.

**Case Study:** Case study of cases related to development v/s environment.

**Semester IV**  
**PROJECT WORK (4P2)**

The project will carry 100 marks.

Additional Details:

**A) VISIT TO ATLEAST TWO CENTERS OF THE FOLLOWING**

- i) National Environmental Engineering Research Institute (NEERI), Nagpur
- ii) Remote Sensing Center
- iii) Regional Meteorological Center, Nagpur
- iv) Maharashtra Pollution Control Board, Nagpur

**B) FIELD DIARY**

The student shall prepare their field diary under the following heads

- i) Issue on local/regional/national problem of environmental interest (Case Studies).
- ii) About famous personalities in environmental movements.
- iii) New Acts and Judgments of environmental interests.

**C) GUEST LECTURE SERIES:**

In each year guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series (at least five guest lecturers in chosen topics) with compulsory attendance.