

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**  
**Syllabus for Environmental Science**

**M. Sc.-I Year**

**Semester I**

**Paper I**

**Environmental Chemistry**

**Unit I**

**Fundamentals of Chemistry**

**General Chemistry:** Classification of Elements, Theory of Valency, Gas Laws, Chemical Bonds, Measurement of Mass, Temperature, Volume, Length, Pressure, 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. (15)

**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, Synthetic and Processing Pathways, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry. (15)

**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. (15)

#### 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.

(15)

#### 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.

#### Paper II

#### Atmospheric Science

##### 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.

(15)

##### 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.

(15)

### 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. (15)

### 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. (15)

#### 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

### Paper III

#### Environmental Biology

##### 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, Predation, Parasitism and Symbiotic Relationship. (15)

## 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. (15)

## 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. (15)

## 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.

**Environmental Epidemiology:** Pollution Related Diseases and Disorders, Health Hazards. (15)

## 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).*

## **Paper IV**

### **Environmental Microbiology and Biotechnology**

#### **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). (15)

#### **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). (15)

#### **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. (15)

#### **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. (15)

#### **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 Mascus )*

- 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).*

## **SEMISTER I**

### **PRACTICAL – I**

#### **A) ENVIRONMENTAL CHEMISTRY AND ATMOSPHERIC SCIENCE**

1. Laboratory concepts: Rules and regulation, preparation of standard solutions.
2. Weighing capacity and sensitivity of balance –care and use of balance.
3. Water sampling and storage techniques.
4. Examination of water quality with respect to following parameters
  - a) pH, conductivity, density, viscosity, turbidity, colour.
  - b) Acidity, Alkalinity, TDS & DO
5. 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 texture 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 psychrometer

#### **B) ENVIRONMENTAL BIOLOGY, ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**

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 37°C
  - 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**

##### **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. **(15)**

##### **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”, Afforestation, Social Forestry, Conservation, Legislation, National Forest Policy, Joint Forest Management. **(15)**

##### **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, ICUN 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. **(15)**

## 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. (15)

### 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., Busto (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.

## Paper VI

### Natural Resources Management

#### 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). (15)



## **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. (15)

## **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. (15)

## **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. (15)

### **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.*

## Paper VII

### Environmental Sampling and Research Methodology

#### 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. (15)

#### 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. (15)

#### 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). (15)

#### 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, Laboratory Quality Control and Assessment, Correction, Limit of Detection, Bias, Precision and Accuracy. (15)

#### 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 Practises :** *R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008*

## **Paper VIII**

### **Analytical Techniques for Environmental Monitoring**

#### **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. (15)

#### **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. (20)

#### **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. (15)

#### **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). (15)

## 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*

## SEMISTER II

### PRACTICAL – II

#### A) 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

#### B. 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 III

#### **A. 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

#### **B. Analytical techniques**

1. Study of principles components of U.V. visible spectrophoto meter
2. Analysis of sulphate by spectrophoto meter
3. Analysis of phosphate by spectrophoto meter
4. Analysis of nitrate by spectrophoto meter
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

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**

**Model Question Paper (Theory)**

**Class: M. Sc. First Year (Semester First/Second)**

*Subject: Environmental Science*

**Paper I: Environmental Chemistry**

**Paper II: Atmospheric Science**

**Paper III: Environmental Biology**

**Paper IV: Environmental Microbiology and Biotechnology**

**Paper V: Environmental Ecosystem and Biodiversity**

**Paper VI: Natural Resources Management**

**Paper VII: Environmental Sampling & Research Methodology**

**Paper VIII: Analytical Techniques for Environmental Monitoring**

**Time : Three Hours**

**Maximum Marks : 100**

---

Q. 1: Long Question	20 marks
OR	
a) Short Question	10
b) Short Question	10
Q. 2: Long Question	20
OR	

a) Short Question	10
b) Short Question	10
Q. 3: Long Question	20
OR	
a) Short Question	10
b) Short Question	10
Q. 4: Long Question	20
a) Short Question	10
b) Short Question	10
Q. 5: Short Notes (Including all Units) (Solve Any 5)	20
1)	
2)	
3)	
4)	
5)	
6)	
7)	
8)	

**The End**

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**

**Model Question Paper (Practical)**

**Class: M. Sc. First Year (Semester First/Second)**

*Subject: Environmental Science*

**Practical I / II**

**Time : Eight Hours (Spread up in two days)**

**Maximum Marks : 100**

Q. 1: Long Experiment	20 marks
Q. 2: Long Experiment	20
Q. 3: Short Experiment	10
Q. 4: Short Experiment	10
Q. 5: Practical Record	10
Q. 6: Viva	10

-----  
80 Marks

Internal Assessment

20

-----  
Total 100 Marks

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**  
**Syllabus for Environmental Science**  
**M. Sc. – Final Year**

**Semester III**

**Paper IX**

**Water Supply and Resources**

**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. **(15)**

**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. **(15)**

**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. **(15)**

**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. **(15)**

## 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*

## Paper X

### Water and Water Treatment

#### 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. (15)

#### 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. (15)



### **Unit III**

**Water Softening:** Necessity of Water Softening, Types of Hardness, Methods of Water Softening, (Lime, Soda Process, Zeolite Process, Demineralization Process) 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. (15)

### **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. (15)

### **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*

## **Paper XI**

### **Physico- Chemical Treatment of Water & Waste Water**

#### **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. (15)

#### **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. (15)

#### **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 (15)

#### **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. (15)

### 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-Grew Hill Publishing Company, New Delhi* )
10. **A Textbook of Environmental Chemistry & Pollution Control** : S S Dara, S. Chand & Company, New Delhi (2002).

## Paper XII

### Biological Process in Wastewater Treatment

#### 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).

**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. (15)

## 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). (15)

## 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 Screens, Grit Chamber, Skimming Tanks, Primary and Secondary Primary Sedimentation Tanks, Filters, Stabilization Plants, Necessity for Raw Water Conservation. Water Conservation, Recycle and Reuse of Treated Wastewater, Tertiary Treatment, for Reuse. Concept and Guidelines of Common Effluent Treatment Plant (CETP), Combined Effluent Treatment Plants and Sewage Treatment Plants. (15)

## Unit IV

**Advanced Wastewater Treatment:** Concept of Zero Liquid Discharge. Advanced Units & Technologies and their application - High Rate Solid Contact Clarifier (HRSCC), Dissolved Air Floatation Unit (DAF), Submerged Bio-Towers (SBT), Membrane Bio Reactor (MBR), Reverse Osmosis (RO), Multi Effect Evaporator (MEE), and Skid Mounted Sewage Treatment Plants. (15)

### 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* )

## **SEMISTER III**

### **Practical IV**

#### **A. Water Supply and Resources, Water and Water Treatment**

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.

#### **B. Water Treatment and Supply**

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 spectrophoto meter.
4. Determination of chloride by Argntometry/ potantiometry.
5. Determination of sulphate by barium chloride method.
6. Determination of hardness in raw and treated water.
7. Study of water supply in urban area for
  1. Estimation of population
  2. Type of water supply.
  - 3 Maintenance of water supply

## **Semester III**

### **Practical V**

#### **A. Biological Processes in Wastewater Treatment**

1. Study of micro organisms of sewage.
2. Study of physical impurities in sewage.
3. Study of suspended ,dissolves ,total, volatiles solids in sewages.
4. Study of sewage treatment plant with respect to 1. Flow measurement 2. Design of screen, grit chamber, aeration tank and filtration unit.

## **B. Waste Water Treatment**

1. Relative density test for a samples of waste water.
2. Determination of Sludge Volume Index (SVI) of sludge samples.
3. Determination of Sludgs 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)

## **Semester IV**

### **Paper XIII**

#### **Air and Noise Pollution Control Technology**

##### **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. (15)

##### **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<sub>2</sub> and Dust. Collection of Particulates, Dust Fall Jar, 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 Eurostandards). (15)

##### **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>x</sub> removal, Fugitive Emissions. Role of Green Belts. (15)

#### **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. (15)

#### **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.*

#### **Paper XIV**

#### **Solid and Hazardous Waste Management**

##### **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. (15)

## **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, Municipal Solid Waste (Management and Handling Rules 2000). (15)

## **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. (15)

## **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. (15)

### **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*

## **Paper XV**

### **Environmental Impact Assessment and Legislation**

#### **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. (15)

#### **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. (15)

#### **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. (15)

#### **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). (15)

## 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).

## Paper XVI

### Environmental Management

#### 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. (15)

## 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. (15)

## 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. (15)

## 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. (15)

## 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**

### **Practical VI**

#### **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. Determination of sett liable particles in air using dust fall jar apparatus.
7. Determination of sulphonation rate by lead per oxide methods.

#### **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. Identify and study hazardous waste in urban area for toxicity.
6. Study of bio medical waste generation and disposal practices in urban area.

## **Semester IV**

### **Practical VII**

#### **A. Environmental Impact Assessment and Legislation**

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 of the prediction of the impact of the environment.
6. Under take evaluation methods for impact minimization.
7. Critically study environmental protection activity and its applicability in the impact area.
8. Study EIA legislation for environmental protection.

**B. Environmental Management**

1. Preparation of different models for rain water harvesting.
  2. Study of environmental management practices in industries.
  3. Study of total quality management in industries.
  4. Study of environmental management system 14.000 in industries.
  5. Study of topographic and environmental maps.
6. Visit to Disaster Management Cell in urban area for the following disaster
1. Flood
  2. Epidemic
  3. Drought.

**RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR**

**Model Question Paper (Theory)**

**Class: M. Sc. First Year (Semester Thrid/Fourth)**

*Subject: Environmental Science*

**Paper IX : Water Supply Resources**

**Paper X : Water and Water Treatment**

**Paper XI : Waste Water & Physical Treatment**

**Paper XII : Wastewater Treatment**

**Paper XIII : Air and Noise Pollution Control Technology**

**Paper XIV : Solid & Hazardous Waste Management**

**Paper XV : Environmental Impact Assessment and Legislation**

**Paper XVI : Environmental Management**

**Time : Three Hours**

**Maximum Marks : 100**

---

---

Q. 1: Long Question	20 marks
OR	
a) Short Question	10
b) Short Question	10
Q. 2: Long Question	20
OR	
a) Short Question	10
b) Short Question	10
Q. 3: Long Question	20
OR	
a) Short Question	10
b) Short Question	10
Q. 4: Long Question	20
a) Short Question	10
b) Short Question	10
Q. 5: Short Notes (Including all Units) (Solve Any 4)	20
1)	
2)	
3)	
4)	
5)	
6)	
7)	
8)	

**The End**

**Model Question Paper (Theory)**  
**Class: M. Sc. First Year (Semester Thrid)**  
*Subject: Environmental Science*  
**Practical I / II**

**Time : Three Hours**

**Maximum Marks : 100**

---

---

Q. 1: Long Experiment	20 marks
Q. 2: Long Experiment	20
Q. 3: Short Experiment	10
Q. 4: Short Experiment	10
Q. 5: Practical Record	10
Q. 6: Viva	10

-----  
80 Marks  
20

Internal Assessment

-----  
Total 100 Marks

**Model Question Paper (Theory)**  
**Class: M. Sc. First Year (Semester Fourth)**  
*Subject: Environmental Science*  
**Practical I**

**Time : Three Hours**

**Maximum Marks : 100**

---

---

Q. 1: Long Experiment	20 marks
Q. 2: Long Experiment	20
Q. 3: Short Experiment	10
Q. 4: Short Experiment	10
Q. 5: Practical Record	10
Q. 6: Viva	10

-----  
80 Marks  
20

Internal Assessment

-----  
Total 100 Marks

### **Research based project work (Instructions for Students).**

Candidates will write a project on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The project work must consist of review of literature and produce a deep insight of the subject on the basis of personal research.

Project work will be initiated after passing M.Sc.-I. The students will undertake field work in terms of collection of data and surveys. The project will have to be submitted at the end of the academic year for appraisal and acceptance by the University. The students should submit their project in the following format.

#### **Chapter I: Introduction with Aims and Objectives.**

A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study.

#### **Chapter II: Methodology with Material and Methods.**

Description of the issue, methodology adopted for the study.

#### **Chapter III: Experimental**

Presentation of data collected and detailed analysis of results.

#### **Chapter IV: Result and Discussion**

Discussion on the data and results obtained and presentation of method suggested to solve the problem.

#### **Chapter V: Summary and Conclusions.**

A summary of the dissertation and important conclusions drawn at the end of the investigation.

#### **Chapter VI : Bibliography or References**

A list of references of cited in the text.

The project should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. If the project contains such mistakes the student will have to resubmit their project after the necessary corrections. The project should be bound in hard black mounted cover. Project with spiral binding and paper cover will not be accepted. The students are expected to prepare 4 copies of the project of which three should be submitted to the University.

The project will carry 100 marks. Assessment of the project will be done at the end of the year. Students have to appear for PowerPoint presentation and shall carry 10 marks. Students will have to submit their project one month before the final practical examination. Assessment of the project shall be done by the Supervisor appointed by the Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.



**Distribution of Marks**  
**Maximum Marks : 100**

01.	Introduction & Review of literature	10
02.	Subject Knowledge	10
03.	Reasoning Capability	10
04.	Interpretation of Results	10
05.	Efforts Taken	10
06.	Presentation of Work	10
07.	Power point presentation	10
08.	Project Viva	10
09.	Internal Assessment	20

-----  
Total 100 Marks

**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) SEMINAR**

Student may select any environmental related topic of their choice (in consultation with the faculty) and make a power point presentation for 30 minutes. They shall be able to answer questions invited from the audience.

25 Marks

**C) 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.

**D) 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.

### Teaching Work Load Per Week

Class	Per Theory	Per Practical	Per Theory Paper	Practical	Total
M.Sc. I	4 Hrs	9 Hrs	20 Hrs	36 (Two Batches)	56
M.Sc. II	4 Hrs	9 Hrs	20 Hrs	36 (Two Batches)	56

N.B.: Project is considered as the separate paper at M.Sc. Part II and the work load allotted as per theory paper.