

M. Sc. Environmental Science CBCS Syllabus: Semester Pattern 2015-2016

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
Choice based Credit System (CBCS) Syllabus for Environmental Science
M. Sc. – I and II w.e.f June 2015-2016

	Semester-I	Semester-II	Semester-III	Semester-IV
Core Courses	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 and Research Methodology Paper VIII- Analytical Techniques for Environmental Monitoring	Paper IX-Water and Water Treatment Paper X-Physico- Chemical Treatment of Water & Waste Water	Paper XIII-Air and Noise Pollution Control Technology Paper XIV-Solid and Hazardous Waste Management
Elective Courses	Nil	Nil	(ELECTIVE-I) -Paper XI - Biological Process in Wastewater Treatment (ELECTIVE-II) -Paper XI Water Supply and Resources	(ELECTIVE-I) -Paper XV Environmental Impact Assessment and Legislation (ELECTIVE-II) -Paper XV Environmental Management
Foundation Courses	Nil	Nil	(FOUNDATION-I) -Paper XII Fundamentals of Environmental Science- I	(FOUNDATION-II) -Paper XVI Fundamentals of Environmental Science- II
Practical	Practical – I A) Environmental Chemistry and Atmospheric Science B) Environmental Biology, Environmental Microbiology And Biotechnology	Practical – II A) Environmental Ecosystem and Management B) Natural Resources management Practical -III A)Industrial chemistry B) Analytical techniques	Practical IV <ul style="list-style-type: none"> • Water Treatment and Supply • Waste Water Treatment (ELECTIVE-I) Practical V- Biological Processes in Wastewater Treatment (ELECTIVE-II) Practical V- Water Supply and Resources, Water and Water Treatment	Practical VI <ul style="list-style-type: none"> • Air and Noise Pollution Control Technologies • Solid and Hazardous Waste Management (ELECTIVE-I) Practical VII Environmental Impact Assessment and Legislation (ELECTIVE-II) Practical VII Environmental Management
Industrial Training/Seminar/Project/Guest Lecture	Guest Lectures	Guest Lecture	Industrial Training, Seminar, Report Writing, Guest Lectures	Guest Lectures, Project and Seminar

Semester III
Paper IX
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.

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, 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.

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*

Paper X

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.

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).*

(ELECTIVE-I)

Paper XI

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.

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 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

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.

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*)

(ELECTIVE-II)

Paper XI

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.

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*

SEMISTER III

Practical IV

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 spectrophotometer.
4. Determination of chloride by Argentometry/ potentiometry.
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

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 III

Practical V

(ELECTIVE-I)

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.

(ELECTIVE-II)

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.

Paper XII (Foundation-I)

Fundamentals of Environmental Science- I

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,

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- 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 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.

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 SO₂, NO 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 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, NO₂ 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.*

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.

Unit II

Solid Waste Management: Introduction, Vermiculture, Composting, Biogas from MSW, Land Fill (Site Selection, Site Investigation and Site Characterization), Landfill Planning and n Designing, Construction and Operational Practices, Landfill Quality and Control, Indian Scenario and Legislative Control, 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

(ELECTIVE-I)

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 SocioEconomic 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.

(ELECTIVE-II)
Paper XV
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.

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.

(Foundation-II)

Paper XVI

Fundamentals of Environmental Science- II

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- O₃, H₂O, NH₃, N₂, NO, NO₂, NO₃, CH₄ 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,

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- 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

Practical VI

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_x and NO_x.
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.

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
(ELECTIVE-I)

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.

(ELECTIVE-II)

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.

Research based project work (Instructions for Students).

Candidates will write a proeject 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 wok 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.

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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.

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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.