RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

B.Sc.-I

ENVIRONMENTAL SCIENCE

The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination.

Theory paper is divided into four units. Each unit shall be covered in 7.5 hours.

SEMESTER I

PAPER –I

Fundamentals of Environmental Science

UNIT – I - Basics of Environmental Science

1) **Introduction to Environmental Science:** Definition and Scope of Environmental Science, Multidisciplinary nature of Environmental Science, Theoretical and applied aspects of environmental science, Types of Environment-Natural and Anthropogenic Environment,
2) **Environmental Education:** Objectives, Goals and Guiding principles of Environmental Education (Formal and Non Formal), Celebration of Environmental days, Environmental Organizations and Agencies (National and International), Classification of Total Environment- Segments of Environment and their interactions with each other. **(7.5 Hours)**

UNIT – II - Basics of Atmospheric Science

1) **Atmosphere:** Introduction and History of Atmosphere, Chemical Composition of Atmosphere; Division of Atmosphere - Homosphere, Hetrosphere and Exosphere; Atmospheric Structure on the Basis of Temperature-Troposphere, Stratosphere, Mesosphere and Thermosphere; Chemical Species and Particulates Present in the Atmosphere, Reaction in Atmosphere, Lapse Rate and Temperature Inversion.
2) **Chemical Aspects of Ozone Layer:** Significance, Formation. Depletion, Effects on Human Beings and Environmental Disturbance. **(7.5 Hours)**

UNIT – III - Basics of Climatology

1) **Climatology:** Definition, Difference Between Weather and Climate, Three States of Water, Sources of Atmospheric Moisture, Hydrological Cycle (Water Cycle), Evaporation, Factors Affecting Rate of Evaporation, Condensation, Forms of Condensation- Frost, Fog, Mist, Smog and Clouds, Fog- Classification According to Visibility and on the basis of appearance, Smog- Theory of Formation, Adverse Effects on Human Being, Difference between Smog and Fog. Case Studies.
2) **Clouds:** Definition, Mechanism of Cloud Formation, Classification of Clouds, Role of Clouds in Weather Forecasting, Importance, Basic Types and Methods of Weather Forecasting.

(7.5 Hours)

UNIT – IV- Basics of Meteorology

1) **Meteorology:** Definition, Aims and Objectives of meteorology, Primary Meteorological Parameters -Temperature, Winds and their Origin, Wind direction and Wind Speed Wind Patterns, Secondary Meteorological Parameters- Humidity, Relative Humidity and Absolute Humidity, Precipitation, Pressure, Solar radiation
2) **Meteorological measurements:** Psychrometer and its Working, Anemometer, Types of Anemometers and their Functions. **(7.5 Hours)**

PAPER –II

Environmental Ecology

UNIT – I - Basics of Ecology

1) **Introduction of Ecology**: Definition, Scope, Relation to Other Disciplines, Subdivisions, Modern Branches of Ecology, Applications and Significance to Human Beings.

2) **Environmental Factors:**
   i. **Abiotic** - Climatic, Topographic and Edaphic Factors.
   ii. **Biotic**-Temperature, Light, Water, Humidity, Microclimate and Fire.

(7.5 Hours)

UNIT - II - Ecological Relationship:

1) **Inter specific and intraspecific relationships-** Neutralisms, Mutualism, Commensalisms, Ammensilism Antagonisms, Antagonistic Relationships, Symbiosis, and Protocorporation, Exploitation, Parasitism, Competition, Predation and symbiotic relationships.
2) **Ecological adaptations:** Adaptations in plants- Hydrophytes, Mesophytes, Xerophytes. Adaptations in Animals- Aquatic and desert. **(7.5 Hours)**

UNIT – III Population and Marine Ecology:

1) **Population Ecology:** Classification of Population and its Characteristics, Natality, (Birth-Rate), Mortality, (Death-Rate), Population Density, Population Growth Curve (S & J shaped curve), Age Distribution, Population Fluctuation, Population Dispersion, Biotic Potential, Concept of Carrying Capacity, Environmental Résistance.

2) **Marine Ecology**: Physico-Chemical Characteristic, Marine Habitat, Zonation in Marine System, Marine Community. Thermal Stratification. Aquatic Adaptations in Marine Plants and Animals**.** **(7.5 Hours)**

UNIT - IV - Community Ecology

1) Introduction to Community Ecology: Definition, Origin and development of community, Characteristics – Species Diversity, Growth Form, Dominance, Tropic Structure, Density, Frequency, Abundance. Ecological Niche, Ecotone and Edge Effect.

2) Ecological Succession: Definition, Types of Ecological Succession, Process, Pattern and Significance. **(7.5 hours)**

PRACTICAL SCHEDULE

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1) To Determine the Relative Humidity of Air Using Psychrometer Consisting of Wet and Dry Bulb Thermometers.
2) Determination of Wind Speed and Wind Direction with Cup and Propeller Type of Anemometer.
3) Measurement of Light Intensity by Lux Meter.
4) Measurement of solar constant.
5) Study of Plant Communities by Quadrate Method and to Study its Characteristic-Density, Frequency and Abundance.
6) Measurement of Primary Productivity in a Water Body by Light & Dark Bottle Method.
7) To Study the Food Chain in an Aquatic Ecosystem.

VISITS:

1) Visit to **Regional Meteorological Centre,** Nagpur.
2) Visit to Nearby **Forest** to Study the Flora in its Natural Environment.

All students shall undertake field visits to the above mention Research Institution, which are important for understanding the subject. Soon after their visit, students shall submit Study Tour Report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY:

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS:

1) Any two experiments	:	16 Marks
2) Viva-voce	:	04 Marks
4) Tour Report	:	04 Marks
5) Practical Record	:	03 Marks
6) Field Diary	:	03 Marks
Total Marks	**:**	**30 Marks**

Books for Reference:

1) Standard methods for Examination of water and waste water, 18th edition 1992, American Public Health Association (APHA), American Water Works Association, New York.

2) Water Quality Sampling and Analysis by S.A. Abbasi, Discovery Publishing House, New Delhi.

3) Environmental Pollution Analysis by S.M. Khopkar.

4) Environmental Analysis by M.M. Saxena, Agro Botanical Publicsher, Bikaner.

5) Laboratory Manual for Environmental Chemistry, Sunita Hooda, S. Chand Publication.

SEMESTER II

PAPER – III
Introduction to Water and Soil Chemistry

UNIT – I - Hydrosphere:

1) **Characteristics of water:** Chemical Composition of Surface, Ground and Sea Waters and their Characteristics, Degradation Due to Natural and Man Made Activities-Sewage and Domestic Wastes, Industrial Effluents, Agricultural Discharges, Toxic Metals and Thermal Pollutants.

2) **Water Sampling and Analysis:** Necessity of Analysis**,** Water Sampling, Types of Water samples, Selection of Sampling Site, Collection, Handling, Preservation of Samples, Information to be Submitted along with the Samples, Various Water Bodies for Sampling, Monitoring Water Quality of a Water Bodies, Presentation and Interpretation of Results. **(7.5 Hours)**

UNIT – II - Physico-Chemical Characteristics of Water Quality:

1) **Physical Parameters**: Colour, Temperature, Taste and Odour, Turbidity, Conductivity, Hydrogen Ion Concentration (pH), Total Solids, Suspended and Dissolved Solids.

2) **Chemical Parameters**: Acidity, Alkalinity, Hardness, Chlorides, Fluorides, Dissolved Oxygen, Principal Involved, Methods of Estimation, Significance and Standards. Water Quality Criteria for Drinking Purpose. Indian Standard Specification for Drinking Water, WHO Guidelines, The safe drinking water act.

(7.5 Hours)

UNIT – III - Pedology

1) **Soil:** Definition, Composition of Soil, Importance of Soil, Components of Soil, Soil Organisms and Role, Formation of Soil, Factors Affecting Soil Formation,

Weathering and Soil type of India, Soil Profile Differentiation, Formation and Weathering of Rocks.

2) **Properties of Soil:**
   i. **Physical Properties:** Soil Textures, Structure of Soil, Soil Density, Porosity of Soil, Permeability of Soil, Soil Colors, Soil Temperature, Soil Air & Soil Water.
   ii. **Chemical Properties of Soils:** Inorganic Matter of Soil, Organic Matter of Soil, Colloidal Properties of Soil, Soil Reactions and Buffering Action, Cation Exchange Capacity, Acidic Soils and Basic Soils. **(7.5 Hours)**

UNIT – IV - Issues of Soil Sciences:

1) **Soil Erosion:** Definition and Types of Erosion, Agencies Causing Soil Erosion, Climate, Water, Wind and Biotic Agencies, Control Measures.

2) **Soil Conservation:** Aims and Objectives. Soil Fertility, Causes and Maintenance, Soil Fertility Factors, Humus-Composition, Characteristics and Functions. Soil Degradation and its Causes, Impacts, National Wasteland Development Board (NWDB). **(7.5 Hours)**

PAPER – IV

Introduction to Ecosystem and Biodiversity

UNIT – I - Basics of Ecosystem

1) **Ecosystems:** Definition, Concept, Characteristics, Components, Structure and Function of an Ecosystem, Types of Ecosystem-Aquatic Ecosystem-Ocean and Pond Ecosystem. Terrestrial Ecosystem-Forest, Desert and Grassland Ecosystem. Food chain, Fodweb. Biomes - Definition, Major biomes of the world.

2) **Biochemical Cycles:** Definition, Classification, Gaseous Type: Oxygen, Carbon and Nitrogen Cycle. **(7.5 Hours)**

UNIT – II - Production Ecology:

1) **Productivity:** Definition, Ecosystem Studies With Special Reference to Productivity, Measuring Primary Productivity. Harvest Method, Oxygen Production Method (Light and Dark Bottle), Carbon Dioxide Assimilation Method, Chlorophyll Method, Radioisotope Method. Factors Affecting Productivity. **(7.5 Hour)**

2) **Biogeochemical cycles**: Role of Biogeochemical Cycle in balancing the Nature, Types of Biogeochemical Cycle. Sedimentary Type- Phosphorous and Sulphur Cycle.

UNIT - III - Forest Ecology

1) **Forestry:** Significance of Forest, Types of Forest in India, Minor forest products, Forest based medicinal and pharmaceutical industries. Deforestation and it Cause, Factors leading to deforestation and effects of deforestation, Afforastation, Reforestation, Joined Forest Management (JFM), Forest fires and its control.

2**)** **Social Forestry**: Concept, scope, need and objectives of social forestry, Types of social forestry, 'Chipko- Movement', National Forest Policy, Forest Protection Act- Silent features. **(7.5 Hours)**

UNIT - IV - Fundamentals of Biodiversity and Conservation.

1) **Biodiversity:** Definition, Types and levels of Biodiversity, Biogeographic classification, Significance, 'Hotspots' of Biodiversity, Factors Responsible for Loss of Biodiversity, Preservation and Conservation Strategies for Biodiversity. Endemic species and Endangered Species.

2) **Biodiversity Conservation:** ***'Ex-Situ'*** Conservation, ***'In-Situ'*** Conservation, Restoration of Wilderness and Green Cover, Methods of Conservation, Imparting Education, Biodiversity Act, Global Agreement and National Concerns, Community Biodiversity Register. **(7.5 Hours)**

PRACTICAL SCHEDULE

1) Water sampling for ground and surface water and its storage techniques.
2) Physico-Chemical Parameters (Colour, Temperature, Turbidity) for Characterizing and Evaluation of Water Quality.
3) Determination of Hydrogen Ion Concentration (pH) of Water and Wastewater.
4) Estimation of Total Solids, Total Dissolved Solids, Total Suspended Solids by gravimetric method of Water and Wastewater.
5) Estimation of of Conductivity of Water and Wastewater.
6) Estimation of Chlorides of Water and Wastewater by Argentometric Method.
7) Estimation of Alkalinity of Water and Wastewater.
8) Estimation of Acidity of Water and Wastewater.
9) Estimation of Total Hardness of Water and Wastewater.
10) Soil sampling methodology by quartering method.
11) Analysis of Soil *with respect to* following significant parameters.
    i) Determination of Bulk Density of Soil.
    ii) Determination of Moisture Content of Soil.
    iii) Determination of Water Holding Capacity of Soil.
    iv) Determination of Soil Texture of Soil.

VISITS:

1) Visit to **Regional Meteorological Centre,** Nagpur.
2) Visit to nearby **Forest** to study the flora in its natural environment.

All students shall undertake field visits to the above mention Research Institution, which are important for understanding the subject. Soon after their visit, students shall submit Study Tour Report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY:

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. New Acts & Judgments of Environmental Interest.
4. About Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS:

3) Any two experiments from Section-A	:	08 Marks
4) Any two experiments from Section-B	:	08 Marks
5) Viva-voce	:	04 Marks
4) Tour Report	:	04 Marks
5) Practical Record	:	03 Marks
6) Field Diary	:	03 Marks
Total Marks	**:**	**30 Marks**

Books for Reference (Practicals) :

1) A Manual of Water Wastewater Analysis by Dr. D.S. Ramteke & C.A. Moghe, Published by NEERI, Nagpur, 1996

2) Physico-Chemical Examination of Water Industrial Effluents by N. Manivaskaram, Pragati Prakashan, Meerut (U.P.) 1996.

3) Laboratory Manual of Environmental Chemistry by Dr. Sunita Hooda & Dr. Sumanjeet Kaur, S.Chand & Co. Ltd.New Delhi, 1997.

4)Handbook of Environmental Analysis" by Predict Pataki, Lewis Publishers, USA, 2000.

5) Chemical and Biological Methods of Water Pollution Studies" by R.K. Trivedy & P.K.Goel, Enviro Media Publication

Books for Reference:

1. Text Book of Environment by K.M. Agrawal, P.K. Sikdar and S.C. Deb, Mc'millan Publication, Mumbai.

2. Environmental Awareness and Education V.P. Kudesia, Education Publishers, Meerut (U.P).

3. Man and Environment by M.C. Dash and P.C. Mishra, Mc'millan Publicatio, Mumbai.

4. Environmental Science by S.C. Santra, New Central Book Pvt. Ltd, Kolkatta.

5. The Nature and Properties of Soils by Nyle C., Brady Eurasia Publishing House Ltd. New, Delhi, 1988.

6. Climatology by D.S. Lal. Sharda Pupstak Bhawan, Allahabad, 2001.

7. Meteorology by Dr. S.R. Gadekar, Agromet Publishers Nagpur, 2000.

8. An Introduction to Environmental Management by Dr. Anand S.Bal, Himalaya Publishing House.

9. A Textbook of Environmental Studies by Dr. (Mrs.) Shanta Satyanarayan, Dr. Suresh. Zade, Dr. Shashikant Sitre & Dr. P. U. Meshram. Allied Publishers, New Delhi.

10. Environmental Chemistry by A.K. Dey, Wiley Eastern Ltd, New Delhi, 1989.

11. Elements of Environmental Science by P. Meenakshi, Prentice Hall India, New Delhi.

12. Environmental Problems and Solution by D.K. Asthana, S.Chand Publication.

13. Environmental Awareness by K.C. Chandana, Kalayni Pulisher (U.P.) 1998.

14. Meteorology by Moran and Morgan, Mcmillan college publishing company, New York.

15. Environmental Analysis by M.M. Saxena, Agro Botanical Publisher, Bikaner.

16. Ecology by E.P. Odum, Oxford and IBH Publishing Company.

17. Fundamentals of Ecology M.C. Dash and S.P. Dash, McGraw Hills companies.

18. Ecology by Russel, Wolfe, Hertz, Starr, McMillan, Cengage Learning Publication.

19. Environmental Biology- P.S. Verma, V.K. Agrawal, S. Chand & Co. Ltd., New Delhi, 2001.

20. Environmental Biology by Biswarup Mukerjee, Tata Mcgraw- Hill Publishing Co. Ltd, New Delhi, 1996.

21. Environmental Biology by K.C Agrawal, Agro Botanical Publisher, Bikaner, 1994.

22. Environmental Ecology by Gurudeep Raj, P.R Trivedy, Akashdeep Publishing House, New Delhi, 2000.

23. Animal Ecology and Distribution of Animals Veer Bala Rastogi, Rastogi Publication, Meerut, (U.P.).

24. Plant Ecology and Soil Science by R.S. Shukla, P.S. Chandel, S. Chand & Co. Ltd., New Delhi, 2001.

25. Ecology by M.P. Arora, Himalaya Publishing House, Nagpur, 2001.

26. Hand Book of Agricultural Science" S.S. Sing, Kalyani Publisher (U.P.), 1999.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
B. Sc. Part II
Environmental Science
Semester III and IV

Year	Semester	Paper	Paper Title	Total Periods/Week	Marks		Total Marks	Total Marks
					Theory	Internal		
B. Sc. Part II	**III**	P-V	Environmental Chemistry and Instrumentations	03	50	10	60	150
		P-VI	Environmental Microbiology and Water Treatment	03	50	10	60	
		Practical	Practical-I	06	30	-	30	
	IV	P-VII	Soil Pollution and Waste Management	03	50	10	60	150
		P-VIII	Natural Resources and GIS	03	50	10	60	
		Practical	Practical-II	06	30	-	30	

Note: The Syllabus is based on 6 theory periods per week and 6 practical periods per week per batch.

B. Sc. Part II
Environmental Science
Semester III

The examination shall comprise two theory papers of 3 hours duration and 50 marks each. Practical examination will be of 5 hours duration and of 30 marks. Candidates are expected to pass separately in theory and practical examination. The Syllabus is based on **6** theory periods and **6** practical periods per week. **Eight** periods are allotted for each unit.

Paper V
Environmental Chemistry and Instrumentations

Unit I: Aquatic Chemistry

1. Characteristics of Water: Structure of Water, Water Balance, Physical Properties of Water (Specific heat, Latent heat, Thermal conductivity, Expansion and freezing, Viscosity, Surface tension, Solvency, Buoyancy, Pressure, Salinity. Chemical properties of water (Solubility of gases in water-Oxygen, Nitrogen, Carbon dioxide and Hydrogen Sulphide).

2. Surface Water: Subsurface water formation-Zonation, Types of subsurface water, Water use and over exploitation, Availability of water resources, Water demand, Water conflicts.

3. Ocean Water: Brackish water-Estuaries and Deltas, Composition of ocean, Characteristics of World Ocean Structure, Temperature, Density, pH, Balance of dissolved material in ocean.

(8 Periods)

Unit II: Atmospheric Chemistry

1. Earth's Atmosphere: Atmospheric composition, evolution of the atmosphere, Big Bank Theory, distribution of elements, reactions in the atmosphere, Earths Radiations Balance, chemical species and particulate in the atmosphere Chemical reaction in the atmosphere.

2. Green House Effect and Global Warming: Definition, Process, Green house gases, Climate change, Implications of green house effect and global warming, Control measures, Monitoring Assessment, Research, Prediction program.

3. Stratospheric Chemistry: Chemistry of ozone layer, Catalytic and non-catalytic destruction of ozone, Ozone cycle, Formation of ozone hole, Dobson unit, Ozone hole watch, Ozone depleting substances, Montreal Protocol, Chemistry of Chlorofluoro Carbans (CFCs), Beneficial and deleterious Effects, Global Efforts in reducing the consumption of CFCs.

(8 Periods)

Unit III: Basic Instrumental Methods

1. Instrumental Methods: Classification of Instrumental methods, Nephlometry and Turbidometry- Introduction, Theory, Factors affecting measurement, Applications of Turbidometry and Nephlometry in Environmental Studies.

2. Redox Potential and pH Measurement: Introduction, pH Indicator Method, Potentiometric Method, Types of Electrodes, Advantages and Disadvantages, Applications of pH Meter.

3.Conductivity Measurement: Introduction, Definitions of Various Terms, Methods of Conductance Measurement, Applications of Conductivity Measurement.

(8 Periods)

Unit IV: Advanced Instrumental Methods

1. Chromatography: Definition, Theory of chromatographic separation, Stationary and Mobile phase, Classification of chromatographic separations, Principle, Methods and Applications of Thin Layer Chromatography (TLC) and Paper Chromatography, Gas chromatography- Definition, Principle and Applications.

2. Colorimetry: Theory, Lambert's Law, Beer's Law, Working of Colorimetry and Applications.

3. Flame Photometry: Introduction, Principle, Instrumentation, Applications of Flame photometry in environmental analysis.

(8 Periods)

Paper VI
Environmental Microbiology and Water Treatment

Unit I: Basic of Environmental Microbiology

1. Air Microflora: Definition, Sources of Organisms in Air, Isolation of Organisms, Techniques- Sampling and Methods of Isolation, Beneficial and Harmful Effects of Air Microorganisms, Identification of Aeroallergens, Air Borne Diseases and Allergies, Pollution abetment.

2. Soil Microflora: Important Micro-Organisms in Soil, Functions of Micro-Organisms in Soil, Decomposition of Plants and Animal Residues in Soil.

3. Water Microflora: Introduction to Rural and Urban Water Supply, Sources of Micro-Organisms, Water Sampling, Significance of Bacteriological Analysis of Water, Indicators of Pollution, Enumeration of Coliforms (Fecal and Non Fecal) by Multiple Tube Dilution Technique, Standards of Drinking Water Prescribed by WHO and ICMR.

(8 Periods)

Unit II: Public Water Supply and Sanitation

1. **Water supply and Distribution**: Beneficial uses of water, water demand, per capita demand, variation in demand, Causes, Detection and Prevention of wastage of water, Population forecasting, Sources of water supply, Surface and Underground sources, 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, Design and Maintenance of Distribution System.

2. **Epidemiology:** Basic Concept of Epidemiological Issues (Goitre and Fluorosis), Public Health, Water Borne Diseases (Cholera, Typhoid, Infectious, Hepatitis and Gastroenteritis) and Air Borne Diseases (Asthma, Chronic Bronchitis, Lung Cancer and Emphysema)

3. **Environmental Sanitation:** Significance, Urban and Rural Sanitation, Principles of Sanitation, Low Cost Sanitation, Community Sanitation Measures, Health Education, Public Awareness and Existing Scenario.

(8 Periods)

Unit III: Water Treatment

1. **Introduction:** Potability of Water, Objectives and principles of the water treatment, Unit operations and processes, Theory, Mechanisms, Significance of Aeration, Coagulation, Flocculation and Sedimentation.

2. **Filtration:** Objectives of filtration, Classifications of the filters, Operation and backwashing of filters, Design features of Slow Sand & Rapid Sand Filters, Operational problems in water filters, Gravity and pressure filters.

3. **Disinfection:** Theory, Methods and necessity of disinfection, Residual chlorine and its determination, Chemicals used for disinfection of treated water, Application of chlorine and its compounds, Plain chlorination, Pre-chlorination, Post chlorination, Super chlorination, Double chlorination, Break point chlorination, Role of Ozone and UV as a disinfectant.

(8 Periods)

Unit IV: Modern Water Treatment Techniques

1. **Water Softening Processes:** 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, Swimming pool water Treatment.

2. Defluoridation: Occurrence of fluoride in water, Need for removal, Chemical treatment for Defluoridation and mechanism, Health effects, Methods of Defluoridation, Nalgonda Technique.

3. Reverse Osmosis: Introduction, Removal of color, odour and taste, Treatment with activated carbon, Desalination of brackish water, Distillation, Reverse osmosis, Solar distillation, Mineral waters, Quality requirement of packed drinking mineral waters.

(8 Periods)

PRACTICAL SCHEDULE

Practical-I

Section A

1. Analysis of Water for its Potability Test.
2. Determination of Residual Chlorine, Demand and Dose in a Provided Water Sample.
3. Separation of Copper by Solvent extraction method (Cu-DDC).
4. Separation of Nickel by Solvent extraction method (Ni-DMG).
5. Demonstration of Principle, Working, Standardization & Application of pH Meter.
6. Demonstration of Principle, Working, Standardization & Application of Turbidity Meter.
7. Demonstration of Principle, Working, Standardization & Application of Conductivity Meter.
8. Detection of Ni^{2+}, Co^{2+} and Cu^{2+} in a Provided Mixture by Paper Chromatography.
9. Determination of Alkali metals (Sodium and Potassium) in various samples by Flame photometry.
10. Demonstration of Principle, Working, Standardization & Application of Gas Chromatography.
11. Determine alum dose for Defluoridation by using Nalgonda technique.

Section B

1. Enumeration of Bacteria from Air.
2. Enumeration of Bacteria from Water.
3. Enumeration of Bacteria from Soil.
4. Demonstration of Bacteria from Air.
5. Demonstration of Bacteria from Water.
6. Demonstration of Bacteria from Soil.
7. Observation of Motility of Organisms by Hanging Drop Technique.
8. Differential Gram's Staining.
9. Determination of Total Coliforms of water by MPN Technique.
10. Study of micro organisms by Standard Plate Count Method (SPC Method)
11. Determination of Optimum Coagulant Dose, pH and time by Jar Test Apparatus.

VISIT TO THE FOLLOWING CENTERS

1. Anacon Laboratories Pvt. Ltd., Near Ram nagar Square, Nagpur
2. Gorewada Water Purification Plant
3. Kanhan Water Treatment Plant

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit,

students shall submit study tour report which is certified by the HOD is to be submitted at the time of Practical Examination.

FIELD DIARY:

The student shall prepare their Field Diary under the following heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. About Famous Personalities in Environmental Movements.

GUEST LECTURES SERIES:

In each semester, 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 two guest lectures in chosen topic) with compulsory attendance.

DISTRIBUTION OF MARKS:

6)	Any two experiments from Section A	:	08 Marks
7)	Any two experiments from Section B	:	08 Marks
8)	Viva-voce	:	04 Marks
9)	Tour Report	:	04 Marks
10)	Practical record	:	03 Marks
11)	Field Diary	:	03 Marks
	Total Marks	:	30 Marks

BOOKS FOR REFERENCE:

1. A Textbook of Environmental Studies by Dr. Shanta Satyanaran, Dr. Suresh Zade, Dr. Shashikant Sitre & Dr. Pravin Meshram, Allied Publishers Pvt. Ltd., New Delhi
2. A Textbook of Air Pollution and Control Technologies by Y. Anjaneyulu, Allied Publishers & Ltd. New Delhi, 2002
3. A Textbook of Environmental Chemistry and Pollution Control by S.S.Dara, S.Chand & Company New Delhi.
4. A Textbook of Environmental Chemistry by O.D.Tyagi & M.Mehra Amol Publication New Delhi, 1996
5. A Textbook of Environmental Sciences by R. N. Trivedi, Amol Publication New Delhi.
6. A Textbook of Environmental Pollution by H.V. Jadhav, Himalaya Publishing House, Nagpur, 1997
7. Atmospheric Science and Environment by S.N. Gosh, Allied Publishers Ltd.,2000 New Delhi
8. Environmental Pollution Control Engineering by C.S.Rao, Wiley Eastern Ltd. New Age International Ltd. New Delhi, 1995.
9. Environmental Chemistry by Ajay Kumar Bhagi & G.R. Chatwal Himalaya Publishing House, Nagpur, 2003

10. Environmental Chemistry by Anil Kumar, De New age International (P) Ltd. 1999
11. Environmental Chemistry by B.K. Sharma, Goel Publishing House Meerut,/ Krishna Prakashan Ltd, 2003.
12. Environmental Chemistry by H. Kaur, Pragati Prakashan , Meerut, 2007
13. Environmental Chemistry by M. Sataje, Y. Mido, S.A. Iqbal & M.S. Sethi, Discovery Publishing House New Delhi, 1994
14. Environmental Issues and Options by C.S.K Mishra, J. W. Kim & Amita Saxna, Daya Publishing House Delhi, 2006
15. Environmental Problems and Solutions by D.K. Asthana & Meera Asthana, S.Chand & Company Ltd. New Delhi, 2003
16. Environmental Science by S.C.Santra, New Central Agency Ltd. Kolkata, 2005.
17. Manual of Water and Wastewater Analysis by Dr. D.S. Ramteke, C.A. Moghe & R.Sarin, NEERI, Nagpur
18. Our Environment Pollution Control and Future Strategies by M.P.Mishra, S.Chand & Company Ltd. New Delhi, 2000.
19. Principals of Environmental Science by H.V. Jadhav, Himalaya Publishing House, New Delhi, 1994
20. Water and Wastewater Technology by Mark J. Hammer, Prentice Hall of India Pvt. Ltd., New Delhi, 1998
21. Water Pollution by B. K. Sharma, Krishna Prakashan Media Pvt. Ltd., 2001
22. Water Treatment Technologies and Environment by S.N. Kaul, Lidia Szpyrkowicz & Arvind Kumar, Dyaya Publishing House Delhi, 2004.
23. Environmental Chemistry by P.S. Sindhu, New International Pvt. Ltd, New Delhi.2002
24. Textbook of environmental Chemistry, Pani, Balram, I. K. International Publishing House, New Delhi,2007
25. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House. Delhi, 2009.
26. Elements of Env. Engg by K.L. Duggal S. Chand. Comp.
27. Instrumental Methods of Chemical Analysis by B.K. Sharma, Goel Publishing House Meerut
28. Text Book Of Environmental Engg, by P.V. Prentice Hall Of India 2002.
29. Water Microbiology Vol.I & II by C.B.Powar & H. F. Daginawala, Himalaya Publication Corp.
30. Chemistry For Environmental Engineering by E.N.Sawyer, Mcgraw Hill Book Co, New York.1978
31. Environmental Chemistry by M,Satake, Y.Mido, Discovery Publishing House, New Delhi, 2003.
32. Chemical and Biological Methods of Water of Water Pollution Studies, by R.K.Trivedi & P.K.Goel, Enviro Media Pub. Karhad, 2000.
33. Text Book of Environmental Chem by S.S. Dara. S. Chand & Co-New Delhi.2002.
34. Environmental chemistry, Baird. Colin,W H Freeman and Company, New York.
35. Environment measurement (concept and approach), N. Rajvaidya and Dilip, APH Publishing corporation, New delhi,2011.
36. Tade, RL 1995. Soil Microbiology. John Wiley and sons, New York. p.398.
37. Dirk van Elsas, J., T.Trevors and MH Wellington, 1998. Modern Soil Microbiology.
38. Environmental Engineering- Gerard Kiely, The McGraw-Hill Company
39. Environmental Science and Engineering- J Glynn Henry and G W Heinke, PHI Learning Private Limited.

40. Water supply and sanitary engineering : R. C. rangwala and S. C. rangwala (Charotal publishing house, Anand).
41. A Text book of Sanitary Engineering : Vinayak Gharpure (Engineering Book Publishing Company, Pune)
42. Waste water Engineering : Metcalf and Eddy (Tata Mc-Grew Hill Publishing Company, New Delhi).
43. Technical Manual for Water and Wastewater Analysis by Sunil P. Pande & Leena S. Deshpande , Himalaya Publishing House.
44. Manual of Environmental Analysis by N.C. Aery, Ane Books Pvt. Ltd.

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B. Sc. Part II
Environmental Science
Semester IV

The examination shall comprise two theory papers of 3 hours duration and 50 marks each. Practical examination will be of 5 hours duration and of 30 marks. Candidates are expected to pass separately in theory and practical examination. The Syllabus is based on **6** theory periods and **6** practical periods per week. **Eight** periods are allotted for each unit.

Paper VII
Soil Pollution and Waste Management

Unit I: Soil Pollution

1.Soil Pollution and Pollutants: Definition, Causes and Sources, Classification, Detrimental Effects, Degradation of Different Pesticides in Soil, Different Types of Synthetic Fertilizers (NPK) and their interactions with Different Components of the Soil, Methods to Minimize Soil Pollution, Soil Sampling, Objectives and Site Selection Criteria, Collection and Handling of Soil.

2.Pesticides Pollution: Sources, Effects & Types of Pesticides, Control Measures, Bioaccumulation, Biomagnification and Biotransformation, Toxicology of Major Pesticides, DDT in Environment, Eco-friendly Pesticides, Major Pesticide Episodes.

3.Land Protection: The Land Use Plan, Soil Surveys in Relation to Land Use Planning, Methods of Site Selection & Evaluation, Bio-Remediation of Contaminated Soil, Integrated Plant Nutrient Management, Integrated Pest Management, Land Use Pattern, Urban and Rural Planning for India.

(8 Periods)

Unit II: Solid Waste

1.Municipal Solid Waste: Definition, Sources of Solid Waste, Objectives, Classification, Composition of Municipal Solid Waste, Physical, Chemical and Biological Properties of Solid Waste.

2.Collection and Handling: Solid Waste Generation Rate and their Factors, Handling and Separation of Solid Waste at the Source, Solid Waste Collection, Types of Collection System & Equipment, Time and Frequency of collection, Factors affecting collection, Source reduction of wastes, Need for transfer and transport, Transport stations, Compatibility, Storage, Labeling of waste.

3.Treatment and Disposal: Methods of Treatment and Disposal (Composting, Sanitary Landfill), Thermal Processes (Incineration and Pyrolysis), Recycling and Reuse of Solid Waste, Waste Minimization Technique, Local Scenario - Municipal Solid waste generation.

(8 Periods)

Unit III: Solid Waste Management

1.Solid Waste Sampling: Objectives of Solid Waste Sampling, Site Selection Criteria, Collection and Handling of Solid Waste Samples.

2.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).

3. Processing of Solid Waste: Recovery of Biological Conversion Products, Environmental Effects of Composting and Biogasification.

(8 Periods)

Unit IV: Introduction to Hazardous Waste

1. Hazardous Waste : Definition, Classification- Radioactive Waste, Nuclear Waste, Biomedical Waste, Chemical Waste and Electronic Waste (E-waste) Environmental Effects and Problems, Methods of Treatment and Disposal, Identification and Management of Hazardous Wastes, Physical, Chemical and Biological Methods, Off-side Disposal, Co-disposal and Secured Landfill, Guidelines and Acts Related to Management of Hazardous Waste in India.

2. Hazardous Waste Management: 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.

3. Biomedical Waste: Categories of Biomedical Waste,Colour coding and Type of container for disposal of Biomedical Waste, Contaminated Site Remediation- *Ex-Situ* and *In-Situ* Approach, Landmark Episodes.

(8 Periods)

Paper VIII
Natural Resources and GIS

Unit I:Energy Resources and Conservation

1. Natural Resources: Definition and Classification- Renewable, Non-Renewable and Mineral Resources.

2.Renewable (Non Conventional Sources of Energy): Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Biomass Energy (Biogas), Biogas Manufacturing Process, Types of Biogas Plants, Applications of Biogas, Advantages & Disadvantages of Biogas Plants, Ocean Energy and Magneto-Hydrodynamic Power, Advantages and Disadvantages, Impacts on Environment and their Applications, Energy Production, Consumption and Pattern.

3.Non-Renewable (Conventional Source of Energy): Thermal Power, Hydro Energy, Atomic Energy, Nuclear Energy (Fission and Fission), and Fossil Fuels (Coal, Petroleum, Oil and Natural Gas),Conservation of Energy-Importance, Methods of Conservation, Daunting Energy Scenario, Role of Dept. of Non-Conventional Energy Sources (DNES), Eco-Friendly Energy Sources, Bio-Fuels, Liquid Petroleum Gas (LPG), Compress Natural Gas (CNG).

(8 Periods)

Unit II: Earth's Resources

1.Land Resources: Agricultural Practices in India- Exploitation of Agricultural Land, Range Land Management, Quarrying and their Impacts, Desertification, Desert development programmes, Prevention and expansion of deserts. Land use pattern and Policy for India.

2.Mineral Resources: Metals and Non-Metals, Formation of Mineral Deposits, Consequences of Over Exploitation and Conservation of Mineral Resources.

3.Water Resources: Types of Water Sources, Surface Sources- General, Sources of Water, Streams, Lakes, Rivers, Ponds, Impounded Reservoirs, Stored Rainwater, Introduction to Watershed, Basic concept and significance, Physical and hydrological characteristics of watershed, Types- Macro and Micro watershed, Big dams-

Controversies of big dam, Construction of low cost of dam, Current issues in context with Tehri and Almatti Dam, Rainwater harvesting-Aims and Objectives, Roof top rainwater harvesting- Conservation, Details of pit, Selection of sand media, Quality of pit outlet, Construction of pit in agriculture land for water storage.

(8 Periods)

Unit III: Natural Catastrophes and Disaster Management

1. Natural Catastrophes: Types, Causes, Impacts, Control measures, Policies for damage control and Case Studies- Floods, Cyclones, Cloud bursting, Hurricanes, Earthquake, Landslides, Volcanism, Tsunami, Droughts and Avalanche, El-Nino, La-Nino phenomenon.

2. Risk Assessment: Prediction, Magnitude of problem, Assessment of disaster, Warning and evacuation, Consolidated preparation for next Disaster, Disaster mitigation mapping, Natural and Manmade hazards, Analysis and Mapping.

3. Disaster Management: Disaster Preparedness, Disaster mitigation Programmes in India, Rescue and Relief Operation, Risk mitigating strategies, National Disaster Management Authority of India-its role and salient features.

(8 Periods)

Unit IV: Remote Sensing and GIS

1. Remote sensing: Definition, Concept of Remote sensing, Development of Remote Sensing, Emission of electromagnetic radiation (EMR), Use of microwave for Remote Sensing.

2. Image processing: Digital image processing, Digitisation procedure, Image restoration, Spectra of environmental components, Spectral characteristic of earth features (vegetation, soils, reflectance of rocks & water).

3. GIS and its applications: Definition, Components of GIS, GIS process system, Role in pollution monitoring, Forest cover, Earthquake, Landslide, Nuclear, Chemical and Measuring wetland loss.

(8 Periods)

PRACTICAL SCHDULE

Practical-II

Section A

1 Soil sampling methodology by quartering method.
2 Sampling of soils from different polluted sites.
3 Determination of Cation Exchange Capacity of a Provided Soil Sample.
4 Determination of Sodium – Adsorption Ratio.
5 Determination of Nitrogen, Phosphorus & Potassium of Soil.

6 Determination of Total Organic Carbon & Percent Organic matter in the given soil sample.
7 Analysis of soil sample for micronutrients (Fe, Zn, Mn).
8 Determination of Solid Waste Index.
9 Determination of Moisture Content of a Solid Waste Sample by Gravimetric method.
10 Determination Calorific Value of a Sample of Municipal Solid Waste by Bomb calorimetry.
11 Determination of Volatile and Non-Volatile Matter in a Sample of Municipal Solid Waste.

Section B

1. Demonstration on non conventional energy resource systemi.e. Solar cooker and Solar water heater.
2. Determination of Solar intensity by Lux meter.
3. Study of biogas plant/anaerobic reactor for efficiency
   a. Analysis of biogas slurry for Acidity and alkalinity.
   b. Analysis of biogas slurry for solids (Total Solids, Total Suspended Solids).
4. Analysis of Vermicompost for Physico-chemical analysis with respect to Total Nitrogen and Phosphate.
4. Measurement of the rainfall by Rain gauze.
5. Analysis of ground water quality for Total solids, Fluoride and Iron for its potability test.
6. Study of Remote Sensing techniques.
7. Interpretation techniques for Aerial photographs and satellite imageries.
8. Vegetation mapping by using Aerial photographs.
9. Vegetation mapping by using Satellite imageries.
10. Demonstration of Land use pattern of the region.

VISIT TO THE FOLLOWING CENTERS

1. Visit to a Solid Waste Dumping Site.
2. National Bureau of Soil Survey and Land Use Planning, Nagpur
3. Maharashtra Remote Sensing Application Centre, Nagpur

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY:

The student shall prepare their Field Diary under the following heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. About Famous Personalities in Environmental Movements.

GUEST LECTURE SERIES:

In each semester, 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 two guest lectures in chosen topic) with compulsory attendance.

DISTRIBUTION OF MARKS:

1)	Any two experiments from Section A	:	08 Marks
2)	Any two experiments from Section B	:	08 Marks
3)	Viva-voce	:	04 Marks
4)	Tour Report	:	04 Marks
5)	Practical record	:	03 Marks
6)	Field Diary	:	03 Marks
	Total Marks	:	30 Marks

BOOKS FOR REFERENCE:

1. Energy Resources and Environment by V.K. Prabhakar Anmol Publ.
2. Basic Concepts of Soil Sciences by A.K.Kolay, Wiley Eastern Ltd.
3. Non Conventional Energy Sources by G.D.Rai. Khanna, Publ. New Delhi
4. Environmental Sanitation by Baljeet Kappor, S.Chand & Co. 2001.
5. Environmental Biology and Toxicology- P.D. Sharma, Rastogi Publication, 2004.
6. Environmental Science- W .Cunningham and Saigo, McGraw Hill, New York.
7. A Textbook of Environment- Agrawal, Mcmillion publication, Mumbai
8. Environmental Chemistry- S. S. Dara, S. Chand and Company, NewDelhi2002.
9. Environmental Chemistry- B.K. Sharma, Goel Publication, Meerut.
10. Environmental Science- S. C. Santra, New Central Book Agency private Limited, 2006.
11. Fundamental Concepts of Environmental Chemistry- G. S. Sodhi, Narosa Publishing House, New Delhi, 2002
12. A Textbook of Environmental Science- R.N. Trivedi, Anmol Publications Private Limited, 1997
13. Man and Environment- P. R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi, 1997.
14. Fundamental Concepts in Environmental Studies- Dr. D. D. Mishra, S. Chand Publication, 2009.
15. Environmental Chemistry- A. K. De, New Age International Publishers, 2001.
16. Industrial Safety and Environment- Anupama Prasar. S. K .Kataria & Sons, Delhi

17. Environmental Chemistry- P. S. Sandhu, New Age International Publishers, Mumbai
18. Environmental education and solid waste management, Nag, n. a.
19. Solid Waste Management In Developing Countries (1983) by A.D.Bhide & B.B. Sundaresan, INSDOC, New Delhi.
20. Remote sensing of the environment by John Jensen, Pearson, Second edition.
21. Environmental risks and hazards by Susan Cutter,Prentice hall of india pvt. Ltd,New Delhi.
22. Fundamentals of Remote Sensing: George Joseph, Universities Press Hyderabad,
23. 2005
24. Remote Sensing and GIS : M. Anji Reddy, BS Publications, Hyderabad, 2008
25. Remote Sensing Techniques in Agriculture : D. D. Sahu, R. M. Solanki, Agrobios
26. India, Jodhpur, 2008
27. GIS Basics : Shahab Fazal, New Age International Publishers, New Delhi, 2008
28. Geographical Information Systems : Anil K. Jamwal, Jnanda Prakashan, New
29. Delhi, 2008
    Solid waste pollution : Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi,
30. 2008
31. Principals of Soil Science : M. M. Rai, McMillon Publication.
32. pollution & Soil organisms : P. C. Mishra
33. Textbook of solid wastes management by Khan Iqbal and Ahsan Naved,CBS Publishers and distributors, New Delhi.

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B.Sc. Part-III

Environmental Science

Semester V and VI

Year	Semester	Paper	Paper Title	Total Periods / Week	Marks		Total Marks	Total Marks
					Theory	Internal		
B.Sc. Part-III	**V**	P- IX	**Principles of Air & Noise Pollution**	03	50	10	60	150
		P-X	**Environmental Management**	03	50	10	60	
		Practical	Practical – I	06	30	-	30	
	VI	P- XI	**Water Pollution: Monitoring & Management**	03	50	10	60	150
		P-XII	**Water Supply & Wastewater Treatment**	03	50	10	60	
		Practical	Practical - II	06	30	-	30	

Note : **The Syllabus is based on 6 theory periods per week and 6 practical periods per week per batch.**

B. Sc. Part III

Environmental Science

Semester V

The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination. Theory paper is divided into four units. Each unit shall be covered in 8 hours.

Paper IX

Principles of Air and Noise Pollution

Unit –I : Introduction to Air Pollution

1. **Basic Concepts of Air Pollution**: Definition, Causes, Sources (Natural and Anthropogenic)
2. **Air Pollutants**: Chemistry of Air Pollutants, Classification, Primary Air Pollutants (Sulphur dioxide, Nitrogen dioxide, Carbon dioxide, Hydrocarbons & Particulate matter), Secondary Air Pollutants (Ozone, PAN & Photochemical smog) & their Effects on Human beings, Plants, Animals and Materials, Units of Air Pollutants.
3. **Air Pollution and Meteorology:** Factors Influencing Air Pollution, Methods for Measurement, Temperature, Inversion, Lapse Rates, Stability, Wind velocity, Wind Roses and Turbulence.

(8 Periods)

Unit II : Problems and Control Measures of Air Pollution

1. **Global Problems Associated with Air Pollution:** Acid rain and its Adverse Effects, Control Measures, Indoor air pollution and Mitigation Measures, Air pollution Episodes.
2. **Prevention and Control of Air Pollution:** Methods of Control of Air Pollution, Air Pollution Control Equipments and Devices - Gravity Settling Chambers, Cyclone Collectors, Fabric Filters, Electrostatic **Precipitators** (Tube and Plate type), Scrubbers-(Cyclonic and Ventury Scrubbers), Standards Prescribed for Air Quality in India

3. **Legislative Measures of Air Pollution:** Air Pollution Control Act, Constitutional Provisions, Powers and Responsibilities of CPCB and MPCB.

(8 Periods)

Unit III : Introduction to Vehicular Air Pollution

1. **Genesis of Vehicular Emissions:** Vehicular Pollution, Sources of Air Pollution from Automobiles, Fuel tank, Carburettor, Crank case, Exhaust emissions, Mechanism of Origin of Air Pollution from Automobiles.
2. **Vehicular Air Pollution:** Automobile Emission, Population and Pollution loads of vehicles, Automobile Pollution Control, Control at Sources, Exhaust Gas Treatment Devices, Alternate Fuels Comparison, Diesel, CNG, Biofuels, Thermal Reactor, Catalytic Converter, Global Efforts in Reducing Vehicular Pollution; Indian Scenario.
3. **Legislative Measures of Vehicular Pollution:** Legal Measures, Government Efforts to Control Vehicular pollution, Euro Standards prescribed for Vehicular emission, Motor Vehicle Act, 1988.

(8 Periods)

Unit IV : Introduction to Noise Pollution

1. **Basic Concepts of Noise Pollution**: Definition, Sources of Noise Pollution, Measurement of Noise, The Decibel Scale, Effects of Noise Pollution, Auditory & Non auditory Effects.
2. **Prevention and Control of Noise Pollution**: Equipments used for Noise Measurements, Noise Control Criteria, Noise Control in Industrial Establishments, Important Parameters in Noise Control, Standards Prescribed for Noise with Reference to Indian Context.
3. **Errors in Environmental Analysis:** Definition, Determinate and Indeterminate Errors, Nature and Importance of Errors in Environmental Measurements, Methods of Minimization, Accuracy and Precision, Rejection of Measurement, Measures of Central Tendencies: Mean, Median Range, Average deviation, Standard deviation, Confidence limit and Numerical Problems. Statistical Methods in analysis, Statistical treatment of Environmental Data.

(8 Periods)

Paper-X

Environmental Management

UNIT –I : Basic Concepts of Environmental Impact Assessment

1. **Environmental Impact Assessment (EIA)**: Definition, Origin and Principles of EIA, Objectives, Need, Limitations of EIA, Environmental Impacts of Industrialization and Urbanization, Stages in EIA, Types of EIA, Environmental Inventory, Baseline Information on EIA-Environmental Data, Project Alternatives and Data Management, EIA Monitoring, Risk Assessment, Positive and Negative Impact.
2. **Environmental Impact Statement (EIS):** Definition, Steps for EIS Preparation, Impact Indicators, Prediction of Environmental Impact and Methodologies.
3. **Public Participation**: Public Participation in Environmental Decision Making, Regulatory Requirement, Techniques, Advantages and Disadvantages of Public Participation.

(8 Periods)

UNIT –II : Impact Assessment Methodologies

1. **Methods of EIA**: Criteria for the Selection of EIA Methodologies, Assessment of Environmental Impact and Methods-Adhoc, Checklist, Matrices, Overlays, Basic Steps for Prediction and Assessment of Air Environment, Water Environment and Biological Environment.
2. **Assessment of Impacts:** Overview of Impacts, Directly and Indirectly Measurable Impacts of Air, Water, Land, Noise, Biological, Socio-Economic, Human Health and Environment, Environment Management Plan, Selection of Appropriate Procedures, Development of Green Belt in and around the Industries, Case Studies- EIA of Water Resources and Mining.
3. **Legislation of EIA:** Legislation of EIA in India and Modification, Role of Statutory Agencies in EIA Clearance.

(8 Periods)

UNIT –III : Environmental Audit (EA)

1. **Introduction to Environmental Audit:** Definition, Concepts of Environment Audit and its Importance for Industries, Benefits of EA, Scope and Objectives, Types of Audits, General Audit Methodology , Basic Structure of Audit, Elements of an Audit Process and its Importance.
2. **Environmental Audit in Polluting Industries**: Introduction and Scope, Advantages of EA, Types of EA-Compliance Audit, Surveillance Audit and EMS Audit, Guidelines for Preparation of Audit Report, Pre-Audit Activities, Activities at Site, Post-Audit Activities and Problems Encountered During the Audit.
3. **Significant Environmental Acts:** 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.

(8 Periods)

UNIT –IV : Environmental Awareness and Sustainable Development

1. **Sustainable Development**: Definition, Basic Concept, Objectives and Consequences and Management of Sustainable Development, Principle of Sustainable Development, Case study of Sustainable Development, Global Environmental Democracy, North- South Debate, Emission Trading, Concept of Carrying capacity, Supportive Capacity along with Assimilative Capacity, Modern Concept of Capacity Building in Environmental Management.
2. **People's Participation in Environmental Protection**: Tehri Dam, Apiko Movement, Sardar Sarovar, Narmada Project, Different NGO's in Environment Protection and Their Role at Local, National and International Levels, Concept of ISO 9000 and ISO 14000 in Environmental System Management (ESM).
3. **Environmental Issues:** Ecological Restoration, Principles, Strategies, Restoration Plans and Rehabilitative Measures, Examples of Terrestrial and Aquatic Eco-systems, Restoring Degraded Eco-system in India, Rain Water Harvesting, Application of Remote Sensing in Environmental Protection, Basic Concept of Green Building, Guidelines for Green Rating for Integrated Habitat Assessment.

(8 Periods)

PRACTICAL SCHEDULE

Section A :

1. Determination of Suspended Particulate Matter (SPM) & (RSPM) in Ambient Air by Using High Volume Sampler.
2. Comparative Analysis of Air Sampling from Residential, Commercial & Industrial Zone using key parameters like SO_x & NO_x.
3. Determination of Settleable Particles in Air using Dust Fall Jar Apparatus.
4. Preparation and Intepretation of Wind roses.
5. Concentration of Carbon monoxide (CO) in a given auto exhaust air sample.
6. Concentration of Acid rain in a air sample.
7. Measurement of Noise Pollution by Noise Meter in Silent, Industrial, Residential, Commercial Zones & Comparison its Standards.
8. Demonstration of an Electrostatic Precipitator.
9. Demonstration of Scrubbers and its working.
10. Demonstration of Cyclone Collector and its working.
11. Demonstration of Gravity Settling Chamber and its working.

Section B :

1. Preparation of Environmental Audit Report.
2. Preparation of Model Environmental Impact Assessment Report.
3. Study of natural environment of the area with respect to air, noise, water, soil, socio-economics.
4. Study of environmental impacts of the industries with respect to air, noise, water, soil, socio-economics.
5. Study of EIA legislation for environmental protection.
6. Concentration of Hydrocarbons in a given auto exhausts air sample.
7. Determination of Sulphonation Rate by Lead per oxide Method.
8. Determination of Ammonia in Atmosphere.
9. Determination of Air Pollution Index (API).
10. Impact of air pollution on photo density flux of plant leaves.
11. To estimate the effect of exhaust gases on chlorophyll content in different plants.

FIELD VISITS :

1. Visit to National Environmental Engineering Research Institute (NEERI), Nagpur
2. Visit to Maharashtra Pollution Control Board (MPCB), Udyog Bhavan, Nagpur.

3. Visit to Common effluent treatment plant
4. Visit to Indorama Synthetics, Butibori

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY :

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. New Acts & Judgments of Environmental Interest.
4. About Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS :

1)	Any two experiments from Section	A	:	08 Marks
2)	Any two experiments from section	B	:	08 Marks
3)	Viva-voce		:	04 Marks
4)	Tour Report		:	04 Marks
5)	Practical record		:	03 Marks
6)	Field Diary		:	03 Marks
	Total Marks		:	30 Marks

BOOKS FOR REFERENCE

1. Air Pollution and its control : Sumit malhotra, Pointer publishers, Jaipur
2. Air Pollution : M. N. Rao , Tata McGraw – Hill publishing company, New Delhi
3. Air Pollution : B. K. Sharma, H. Kaur, Krishna prakashan media, Meerut
4. Pollution of our Atmosphere : B. Henderson, Sellers Adam Hilger Limited, Bristol
5. Fundamentals of Air Pollution : Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern, Academic Press, California
6. Air Pollution control Engineering : Noel De Nevers , Mc Graw – Hill international, New York
7. Air Pollution : S. K. Agrawal, A. P. H. Publishing corporation, New Delhi
8. Air Pollution : V. P. Kudesia, Pragati Prakashan, Meerut
9. 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
11. Biostatistics : P. N. Arora, P. K. Malhan, Himalaya publishing House, Delhi, 2008

12. Basic concepts of Biostatistics : N. Arumugam, Saras Publications, Kanyakumari, 2003
13. Biostatistics in theory and Practice : T. K. Saha, Emkay Publications, Delhi, 1992
14. Biostatistics: P. Ramakrishnan, Saras Publications, Kanyakumari, 1995
15. Statistical Methods : S. C. Gupta, S. Chand & Sons Publishers, New Delhi, 1997
16. Evolution Biostatistics & Computer Applications : A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003
17. Environmental Impact Assessment : Principles and Procedures, John Wiley and Sons, New York.
18. Environmental Impact Assessment : A.K.Shrivastav, APH Publishing Corporation,New Delhi.
19. Environmental Impact Assessment: S.A.Abbasi, D.S.Arya,Discovery Publishing House,New Delhi.
20. Environmental Pollution Control : Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation,New Delhi. (2005)
21. Environment Problems and Solutions : D.K.Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi.
22. An Introduction to Environmental Management : Dr.Anand S. Bal, Himalaya Publishing House, New Delhi.
23. Environmental Impact Analysis Handbook : John G.R. and David C.Wooten, McGraw Hill Publications. (1987).
24. Encyclopedia of Ecology and Environment : Environmental Impact Assessment Vol. 7 : By Trivedi P.R., Indian Institute of Ecology and Environment, New Delhi (1999)
25. Environmental Law and Policy in India : Divan S and Rosencraz A,Oxford University Press, New Delhi. (2001)
26. Environmental Laws of India - An Introduction: CPR Environmental Education Centre, Chennai (2001).
27. Environmental impact assessment methodologies: Y.Anjaneyulu,Valli Manickam,Bs Publications
28. Ecology Environmental Science Conservation by J. S. Singh and S. P. Singh and S. R. Gupta , S. Chand Company Ltd.
29. Environmental Pollution, R.K. Khitoliya, S. Chand Company Ltd.
30. Textbook of Environmental Chemistry , Balram Pani,I.K. International Publishing Ltd.

B. Sc. Part III

Environmental Science

Semester VI

The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination. Theory paper is divided into four units. Each unit shall be covered in 8 hours.

Paper-XI

Water Pollution: Monitoring and Management

Unit- I : Introduction to Water Pollution

1. **Basic Concepts of Water Pollution:** Definition, Causes, Sources and Effects of Water Pollution, Ground Water Pollution, Requirement of Fresh Water in India, Case Studies Status of Polluted Rivers like Nag and Kanhan, Ganga Action plan, Interlinking of rivers, Minimata epidemic in Japan.
2. **Water Pollutants:** Classification of Water Pollutants and Their Detrimental Effects, Approaches to Prevent and Control of Water Pollution and Legislative Measures.
3. **Water Quality Monitoring and Management:** Basic concept, Significance and Measurement of BOD & COD, Heavy Metals Sources, Industrial Uses, Prescribed standards, Effects, Chemical Speciation Scheme, Speciation of Mercury (Hg), Cadmium (Cd) Instrumental Methods of Analysis viz Atomic Absorption Spectrophotometer and UV Visible Spectrophotometer and Gas Chromatography, Principle, Components and Application in Environmental Analysis.

(8 Periods)

Unit- II : Global Problems Associated with Water Pollution

1. **Marine Pollution:** Types, Sources and Consequences, Specifications for Disposal of Sewage and Industrial Waste into Sea, Disposal of Sewage & Wash Water from Marine Vehicle (Cargo & Ships).
2. **Oil Pollution**: Sources, Effects, Coastal Management and Episodes, Counter Measures Against Oil Spills.
3. **Eutrophication**: Definition, Sources of Nutrients, N/P Ratio, Types of Eutrophication, Effects, Control and Treatment, Self Purification, Factors Affecting Self Purification, Oxygen Sag Curve, Zones of Pollution, Restoration of Indian lakes.

(8 Periods)

Unit- III : Introduction to Thermal Pollution

1. **Basic Concepts of Thermal pollution:** Definition, Causes and Sources of Thermal Pollution.
2. **Effects of Thermal pollution:** Effects of Thermal pollution on Water Quality with Respect to DO Reduction, Interference with Reproduction of Aquatic Animals, Disruption of Food Chain.
3. **Mitigation Measures of Thermal Pollution:** Cooling and Spray Ponds, Cooling Towers, Criteria of Selecting Site for Thermal Power Plant, Clean Technology for Coal Fired Power Plants, Thermal Power Plant in India, Utilization of Flyash from Thermal Power Stations, Hazards Created by Flyash.

(8 Periods)

Unit- IV : Introduction to Radioactive Pollution

1. **Basic Concepts of Radioactive Pollution**: Definition, Causes and Sources of Radioactive Pollution (Natural and Anthropogenic), Radioactive Fall-out (Mechanism and Types) Classification.
2. **Effects of Radioactive Pollution:** Effects of Ionizing and Non-Ionizing Radiation on Man, Biological Effects, Preventive Measures and Control of Radiation from Nuclear Power Plants, Classification and Management of Hazardous Waste, Treatment and Disposal of Hazardous Chemical Waste, Units of Radiation, Episode-Atom Bomb Disaster in Hiroshima and Chernobyl-World's Worst Nuclear Disaster.

3. **Disposal of Radio-active Waste**: Hazardous Waste, Methods (Dilution and Dispersal) and Decay Concentrate, Recent Methods to Dispose Critically Dangerous Radio-active Wastes.

(8 Periods)

Paper XII

Water Supply and Wastewater Treatment

Unit I: Water Distribution System

1. **Water Supply**: Classification, Gravity System, Direct Pumping System, Methods of Supply, System of Supplying Water (Continuous and Intermittent Systems), Economical and Topographical Considerations.
2. **Distribution System**: Service Reservoir, Classification and their Functions, Layout of Distribution System, Dead End System, Grid Iron System, Ring System, Radial System, Design Consideration of Distribution System, Maintenance of Distribution System, Pumps and Pumping- Necessity of Pumping, Pumps Classification (Displacement Pumps, Centrifugal Pumps), Operation of Pumps, Detection and Prevention of Leakages, Preventive Methods of Leakage.
3. **Environmental Sanitation**: Significance, Urban and Rural Sanitation, Principles of Sanitation, Low Cost Sanitation, Community Sanitation Measures, Health Education, Public Awareness & Role of Environmentalist, Existing Scenario.

(8 Periods)

Unit II : General Aspect of Wastewater Treatment

1. **Wastewater Treatment:** Sources of Wastewater, Objectives of Treatment.
2. **Preliminary Treatment**: Selection and Applications of Screens (Bar Screens, Fine Screens, Self Cleaning and Cutting Screens), Grit Chambers (Aerated & Plain), Primary Treatment-Sedimentation (Septic Tank & Imhoff Tank).
3. **Primary Treatment:** Plane Sedimentation with Coagulation, Filtration & Disinfection Methods.

(8 Periods)

Unit III : Biological Wastewater Treatment

1. **Secondary Treatment (Biological Methods)**: Activated Sludge Process, Oxidation Pond & Trickling Filter and Up-flow Anaerobic Sludge Blanket Reactor.
2. **Tertiary Treatment**: Adsorption, Ion Exchange, Electrolysis, Reverse Osmosis & Treatment with Activated Carbon.
3. **Sludge Handling Treatment and Disposal:** Composition & Characteristics of Sludge, Need for Disposal, Operation & Maintenance of Wastewater Treatment Plant.

(8 Periods)

Unit IV : Industrial Pollution and Treatment Options

1. **Industrialization**: Scope and Importance, Distribution of Industries, Sources and Types of Industrial Effluents, Nature and Origin of Pollutants, Industrial Wastewater and Environmental Impacts on Air, Water and Soil Environment.
2. **Industrial Wastewater Pollutants**: Waste water from some typical Industries, Sources, Characteristics, Effects and Treatment Options for Textiles Industry, Paper and pulp Industry , Dairy Industry, Sugar Industry, Distillery, Polymer Industry, Plastic Recycling Techniques, Biodegradable Plastics.
3. **Unit Operations:** Selection of Appropriate Unit Operations, Monitoring and Designing for the Treatment and Flow Chart of Wastewater Treatment Plant for Electro-plating, Leather Tanning Industry and Fertiliser Industry, Low Cost Waste Treatment and Design.

(8 Periods)

PRACTICAL SCHEDULE

Section A :

2. Determination of Zn^{++} in water by Complexometric Titration.
3. Determination of Cd^{++} in water by Complexometric Titration.
4. Determination of Pb^{++} in water by Complexometric Titration.
5. Determination of Sulphate in a given Water Sample.
6. Determination of Phosphate in a given Water Sample.
7. Estimation of Nitrates by PDA method in a given Water Sample.
8. Estimation of Total Kjeldahl's Nitrogen in a given Water Sample.

9. Estimation of Biochemical Oxygen Demand (B.O.D) by three day method in a given Sample.
10. Determination of Chemical Oxygen Demand (C.O.D) in a given Sample.
11. Demonstration on Eutrophication on polluted lakes.

Section B :

1. Determination of Sludge Volume Index (SVI) of Wastewater Sample.
2. Estimation of Phenol in a given Waste water Sample.
3. Estimation of Sodium and Potassium in given sewage sample.
4. Demonstration of UV-Visible spectrophotometer.
5. Demonstration of Atomic Absorption Spectrophotometer (AAS).
6. Demonstration of Gas Chromatography.
7. Determination of Oxygen Consumption in Normal Fish/Small at Different Temperature.
8. Toxicity Estimation of Heavy Metals Using Fish/Small as Test Animal Determination LC50 Value.
9. Estimation of Chromium in a given Waste Water Sample.
10. Demonstration of Poly Aromatic Hydrocarbons (PAH) in a Water and Waste water.

FIELD VISITS :

1. Visit to Thermal Power Plant, Koradi or Khaparkheda
2. Paper & Pulp. Industry, Bazargaon, Nagpur
3. Diary Plant, Nagpur
4. Jawaharlal Nehru Aluminium Research Design Development Center, Wadi, Nagpur

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY :

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. New Acts & Judgments of Environmental Interest.
4. About Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS :

1)	Any two experiments from Section A	:	08 Marks
2)	Any two experiments from section B	:	08 Marks
3)	Viva-voce	:	04 Marks
4)	Tour Report	:	04 Marks
5)	Practical record	:	03 Marks
6)	Field Diary	:	03 Marks
	Total Marks	:	30 Marks

BOOKS FOR REFERENCE

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66. Chemical And Biological Methods For Water Pollution Studies: R. K. Trivedy, P. K. Goel, Environmental Publication, Karad.

67. Water Pollution and disposal of Waste water on Land : U. N. Mahida (Tata Mc-Grew Hill Publishing Company, New Delhi.

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69. Waste water treatment : M. N. Rao, A. K. Datta (Oxford and IBH publishing company, New Delhi)

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72. Elements of Environment Engineering: K.L. Duggal, S. Chand and Company Ltd.

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