Gondwana University, Gadchiroli

Faculty of Science

Semester wise syllabus for
Post Graduate course in
Environmental Science
M.Sc. I year
Semester I and II

(Choice Based Credit System
w.e.f. the academic year 2016–17)
# Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Environmental science

<table>
<thead>
<tr>
<th>Core Course</th>
<th>Ability Enhancement</th>
<th>Skill Based Course</th>
<th>Discipline specific Elective</th>
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<tr>
<td><strong>SEM I</strong></td>
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<tr>
<td>Core 1 Th. Paper 1 (4 Credits) (4 Hours/Week)</td>
<td>Seminar I (1 Credit) (2 Hours/Week)</td>
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<tr>
<td>PSENV01-Environmental Chemistry</td>
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<tr>
<td>Core 2 Th. Paper 2 (4 Credits) (4 Hours/Week)</td>
<td>PSENV02- Fundamentals of Atmospheric Science</td>
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<td>Core 3 Th. Paper 3 (4 Credits) (4 Hours/Week)</td>
<td>PSENV03- Ecology</td>
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<tr>
<td>Core 4 Th. Paper 4 (4 Credits) (4 Hours/Week)</td>
<td>PSENV04-Environmental Pollution</td>
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<tr>
<td>Practical Core Pr. 1 {Based on Core Th. 1 and 2} (4 Credits) (8 Hours/Week)</td>
<td>PSENV01-Water Sampling Techniques and Analysis</td>
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<td>Practical Core Pr. 2 {Based on Core Th. 3 and 4} (4 Credits) (8 Hours/Week)</td>
<td>PSENV02-Water and Soil Analysis</td>
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Total 25 Credits

P=Postgraduate; S=Science; ENV=Environmental science; Th=Theory; Pr=Practical,
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<thead>
<tr>
<th>Core Subject</th>
<th>Ability Enhancement</th>
<th>Skill Based Course</th>
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<tr>
<td><strong>SEM II</strong></td>
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<tr>
<td>Core 5 Th. Paper 5 (4 Credits) (4 Hours/Week)</td>
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<td>PSENVT05-</td>
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<td>Core 6 Th. Paper 6 (4 Credits) (4 Hours/Week)</td>
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<td>PSENVT06-</td>
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<td>Natural Resources:</td>
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<tr>
<td>Conservation and Management</td>
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<td>Core 7 Th. Paper 7 (4 Credits)</td>
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<td>PSENVT07-</td>
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<td>Environmental Disaster,</td>
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<td>Environmental Biotechnology</td>
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<td>Core 8 Th. Paper 8 (4 Credits) (4 Hours/Week)</td>
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<td>Analytical Techniques</td>
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<td>for Environmental Monitoring</td>
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<td>Pr. Core Pr. 3 {Based on Core Th. 5 and 6} (4 Credits) (8 Hours/Week)</td>
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<td>PSENVP03- Ecology and</td>
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<td>Microbiology</td>
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<td>PSENVP04- Air and</td>
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<tr>
<td>Noise Analysis</td>
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Total 25 Credits
P=Postgraduate; S=Science; ENV=Environmental science; Th=Theory; Pr=Practical
## Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Environmental Science

### SEMESTER I

<table>
<thead>
<tr>
<th>Core</th>
<th>Theory / Practical</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<td>Paper 1</td>
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<td>PSCENVT02</td>
<td>Paper 2</td>
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<tr>
<td>PSCENVT03</td>
<td>Paper 3</td>
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<tr>
<td>PSCENVT04</td>
<td>Paper 4</td>
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<tr>
<td>Practical I</td>
<td>Practical 1</td>
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<tr>
<td>PSCENVP01</td>
<td>Practical 2</td>
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<tr>
<td>Seminar I</td>
<td>Seminar 1</td>
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<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>18</strong></td>
<td><strong>16</strong></td>
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*Practical examination of 12 hours duration spread over two days.

### SEMESTER II

<table>
<thead>
<tr>
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<td></td>
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<td>Hrs/ week</td>
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<td>Theory</td>
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<tr>
<td>PSCENVT05</td>
<td>Paper 5</td>
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<tr>
<td>PSCENVT06</td>
<td>Paper 6</td>
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<tr>
<td>PSCENVT07</td>
<td>Paper 7</td>
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<tr>
<td>PSCENVT08</td>
<td>Paper 8</td>
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<tr>
<td>Practical III</td>
<td>Practical 3</td>
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<tr>
<td>PSCENVP03</td>
<td>Practical 4</td>
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<tr>
<td>Seminar II</td>
<td>Seminar 2</td>
<td>2</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>18</strong></td>
<td><strong>16</strong></td>
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</table>

*Practical examination of 12 hours duration spread over two days.
Note: The syllabus is based on 4 theory periods per week per paper of one hour duration and 8 practical periods per week per batch.

*Internal assessment will be based on actual field work related to environment in any one of the following: Forest Management, Case study, Community Services, Work with NGO’s, Study of environmental practices in industry, Rural development, Local environmental problems.

ELIGIBILITY TO THE COURSE:

Subject to their compliance with the provisions of this direction and of other ordinances in force from time to time, the following applicant candidates shall be eligible for the admission to Master of Science and examinations thereof.

Eligibility for Semester I

| For M.Sc. (Environmental Science) | For admission to the M. Sc. Semester I in Environmental Science, a candidate shall have offered Environmental Science as one of the subject at the B.Sc. level. The candidate having B.Sc. Agriculture Science with XIIth Science is also eligible. |

General Instructions

- Theory examination for all Semesters will be at university level
- The examination of Semester I shall comprise of four theory papers of 3 hours duration of 80 marks each. Twenty marks will be allotted for internal assessment for each theory paper.
- The examination of Semester II shall comprise of four theory papers of 3 hours duration of 80 marks each. Twenty marks will be allotted for internal assessment for each theory paper.
- Question paper will consist of five questions and each question will be of 16 marks.
- Five questions will be based on four units with internal choice.
- Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.
- Practical examination will be of 12 hours duration (spread over two days) and separately for each semester having 80 marks each and 20 marks for internal assessment.
- Practical Examinations for Odd Semester and for Even semester both will be at university level with external examiners.
- The examinee shall be required to pass in theory and practical’s separately.
The syllabus is based on 16 theory periods and 16 practical periods per week.
The marks will be given for all examinations and they will be converted into grade points.
The final grade card will have marks, credits, grades, grade points, SGPA and CGPA.

### Distribution of Practical Marks (Semester I and II each)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Marks</th>
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<tr>
<td>1</td>
<td>One major experiment</td>
<td>30 marks</td>
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<tr>
<td>2</td>
<td>Two minor experiments</td>
<td>30 (15 marks each)</td>
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<tr>
<td>3</td>
<td>Certified practical record book</td>
<td>05 marks</td>
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<tr>
<td>4</td>
<td>Certified tour report/field diary</td>
<td>05 marks</td>
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<tr>
<td>5</td>
<td>Viva-voce</td>
<td>10 marks</td>
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**Total** 80 marks
M.Sc. Environmental Science
Semester I
PSCENVT01
Paper I Environmental Chemistry

Unit I Fundamentals of Chemistry for Environmental Science

1. Fundamentals of Chemistry: Classification of elements, theory of valency, basic concepts of colorimetry from quantitative chemistry, molecular weight, equivalent weight, colorimetry, Lambert’s law, Beer’s law, Nernst distribution law, principle of colloidal chemistry, emulsions, adsorption, absorption.
2. Solution, mole concept, normality, molarity, molality, molar solution, standardization, primary standards, secondary standards, blank titration.
3. Gibb’s energy, chemical potential, chemical equilibria, chemical reactions, solubility product, solubility of gases in water, stoichiometry.

Unit II Basic Concepts of Environmental Chemistry

1. Acid Base Equilibria: Fundamentals of equilibrium diagram, alkalinity and acidity, the carbonic acid system, buffering in water system.
2. Solubility Equilibrium: Slightly soluble salts, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionucleiods.

Unit III Aquatic Chemistry

2. Aquatic Chemistry: Ionic product of water, the hydrogen ion exponent (pH), buffer solutions, purified water-grade 1, grade 2 and grade 3.

Unit IV Soil Chemistry

1. Introduction to Soil Chemistry: Formation of soil, weathering of rocks, composition, soil profile, reactions in soil, cation and anion exchange phenomenon.
PSCENV02

Paper II Fundamentals of Atmospheric Science

Unit I Basic Concepts of Atmospheric Science


Unit II Climatology


Unit III Meteorology


Unit IV Global Warming, Ozone Depletion and Climate Change
2. Ozone Chemistry: Atmospheric ozone, formation of ozone, depletion of ozone, climatic effects and environmental disturbance due to ozone depletion. Antarctic ozone hole and consequences. Advanced research to protect ozone layer.

PSCENVT03

Paper III Ecology

Unit I Fundamentals of Ecology

1. Introduction to Ecology: Origin of term, definition, objectives of ecology, subdivision of ecology, scope of ecology.
3. Limiting Factors: Temperature, light, pressure, humidity, precipitation, fire and microclimate.

Unit II Biotic Environment

1. Fresh Water Ecology: Characteristics of fresh water habitat, transfer of light and its penetration, concentration of respiratory gases (O$_2$ and CO$_2$), concentration of biogenic salts, ecological classification of fresh water habitat (standing water or lentic, running water or lotic).
2. Planktons: Phytoplanktons and zooplanktons, benthos and periphytons as an indicator of water quality and their qualitative and quantitative study. Beneficial and harmful effects of plankton.

Unit III Population and Community Ecology

1. Population Ecology: Definition, characteristics of population - natality, mortality, growth, (S and J shaped curve), fluctuation, dispersion, migration, biotic potential and environmental resistance, concept of carrying capacity
2. Community Ecology: Definition, origin and development of community, characteristic of community- growth, structure, dominance, stratification, periodicity, fluctuation, ecotone, and edge effect, ecological niche.
Unit IV Ecosystem and Eco-stability

2. Biogeochemical Cycles and Productivity: Biogeochemical cycles (Oxygen, Carbon, Nitrogen, Phosphorus and Sulphur). Basic concept of productivity, productivity of different ecosystem, measurement of productivity and the factor affecting productivity.

PSCENVT04

Paper IV Environmental Pollution

Unit I Air Pollution


Unit II Water Pollution

2. Thermal Pollution: Sources, effects and control measures.

Unit III Soil Pollution

1. Soil Pollution: Definition of soil pollution, sources, consequences and control measures.
Unit IV Noise, Solid Waste and Radiation Pollution

1. Introduction to Noise Pollution: Definition, sources, decibel scale, effects of noise pollution. Effects on environment and control measures. Ambient air standard with respect to noise.
2. Solid Waste: Definition, classification, sources, treatment and disposal methods.
3. Introduction to Radiation Pollution: Definition, sources, effects, episodes and control measures.

References

2. A Textbook of Environment: Agrawal, Mcmillion publication, Mumbai
5. Air Pollution: A. C. Stern
16. Industrial Chemistry: B. K. Sharma (Goel Publishing House, Meerut)
20. Environmental Chemistry: Samir K. Banerji (Prentice Hall, New Delhi)
25. **Environmental Analysis**: M.M. Saxena. Agrobotanical Publisher, Bikaner 1994
26. **Climatology**: D.S. Lal. Shraddha Pustak Bhavan Allahabad, 2001
40. **Maintaining Biodiversity in Forest Ecosystem**: Malcolm L. Hunter Jr., Cambridge University Press, 1999
44. **Animal Ecology and Distribution of Animals**: Rastogi, 1790.
45. **Fundamentals of Ecology**: Eugene P. Odum. (Natraj Publishers, Dehradun)
47. **Environmental Biology**: P. D. Sharma. (Rastogi Publications, Meerut)
48. **Ecology and Environment**: P. D. Sharma. (Rastogi Publications, Meerut)
49. **Principles of Environmental Biology**: P. K. G. Nair (Himalaya Publishing House, New Delhi)

50. **Environmental Biology**: M. P. Arora (Himalaya Publishing House, New Delhi)

51. **Ecology and Field Biology**: Robert Leo Smith (Harper Collins College Publication)

52. **General Ecology**: H. D. Kumar (Vikas Publishing house, New Delhi)


56. **Environmental Biology**: K.C. Agarwal, Agro-Botanica, Bikaner.


General Laboratory Practices:
1. Laboratory concepts, rules, regulations and preparation of standard solutions.

Water Sampling:
3. Water sampling and storage techniques.
4. Water sampling programme of surface and groundwater with respective to:
   i) Collection of grab, composite and integrated samples.
   ii) Calculation frequency of samples.
5. Water sampling programme of industrial waste water with respect to grab composite and integrated samples of discharge point.

Water Analysis:
6. Examination of water quality with respect to following physical parameter: Colour, Temperature, Turbidity, Conductivity, Density, Viscosity and Solids and Interpretation of co-relation between pH and Temperature, Conductivity and Solids.
7. Examination of water quality with respect to following chemical parameter: Acidity, Alkalinity, Hardness, Chlorides.
10. Determination of BOD of given wastewater sample for 5 days at 20 °C.
11. Determination of oil and grease by Soxhlet apparatus or separation funnel.

Meteorological Analysis:
13. Determination of wind velocity by three cups Robinson’s anemometer.
15. Determination of current voltage characteristics of Solar Cell.

Water Analysis:
1. Determination of Sulphate by Barium Chloride method.
2. Determination of Sodium and Potassium in water by Flame Photometer.
3. Determination of Iron by o-phenanthroline method.
4. Determination of Chromium by spectrophotometric method.
5. Determination of Manganese by spectrophotometric method.
7. Determination of Copper by Solvent Extraction method and Spectrophotometric method.

**Soil Analysis:**

10. Soil Sampling in agriculture field and wasteland by quartering method.
11. Analysis of organic forming soil for calculating following physical parameter.
    i. Moisture
    ii. Bulk Density
    iii. Texture
    iv. Water holding capacity
    v. Specific gravity
    vi. Conductivity

    i. Acidity
    ii. Alkalinity
    iii. Chlorides
    iv. Hardness
    v. Organic Carbon
    vi. Organic Matter

14. Analysis of Synthetic fertilizer applied soil for various toxic elements such as Cu, Ni, Zn, Mn and silica.
15. Analysis of Soil for nutrient such as:
    1. Sulphate
    2. Phosphate
    3. Nitrate
    4. Potassium
    5. Calcium
    6. Sodium

**References**

2. Water and wastewater Analysis. National Environmental Engineering Research Institute (NEERI), Nagpur
Semester II
PSCENVT05
Paper V Environmental Sampling and Analysis

Unit I Air Sampling

1. Air Sampling: Air pollution sampling, site selection criteria for ambient air and stack sampling, collection of gaseous samples-grab sampling, adsorption and absorption and freezing.
2. Particulate Sampling: Dust Fall Jar, High Volume Sampler, impingement. Stack sampling.
3. Gaseous Sampling: Analysis of SO$_2$, NO$_x$, CO and hydrocarbons.

Unit II Water Sampling

1. Sampling Design: Planning, sites selection for river, groundwater and lake, sampling frequency, flow measurement.
2. Water Sampling: Sampling equipments, types of sample, sampling containers and washing, preservation of water sample.
3. Water Analysis: Analysis of water sample for different physical, inorganic, organic, oxygen demand, trace metals and biological parameters.

Unit III Soil Sampling

2. Sample Preparation: Preparation of soil sample for various analyses.

Unit IV Noise Sampling

2. Sampling of Noise: Site identification, methodology of noise level measurement, instrumentation (sound level meter), Ln, Ld and Ldn. Vehicular noise measurement techniques.
Paper VI Natural Resources: Conservation and Management

Unit I Natural Resources and Conventional Energy

1. Classification of Natural Resources: Primary, secondary and supplementary energy, forest resources-classification, characteristics, distribution, importance and conservation. Wildlife resources, water resources, food and agriculture resources of India. Energy consumption pattern in India.

Unit II Non-conventional Energy

2. Solar Concentrator: Types of concentrator, collectors-line focusing collector, parabolic trough reflector and mirror strip point focusing collector. Electricity generation from solar energy (photovoltaic).

Unit III Hydroenergy

2. Tidal Energy: Basic principle of tidal energy, components of tidal power plant, operation method, advantages and disadvantages.

Unit IV Wind, Geothermal and Biomass

1. Wind Energy : Basic principle of wind energy, classification of wind energy conversion system (horizontal and vertical)
2. Geothermal Energy: Mode of formation, energy conversion, impacts on environment.
Paper VII Environmental Disaster and Environmental Biotechnology

Unit I Environmental Disaster and Management

2. Man Induced Hazards: Dam and dambursts, drought, desertification-causes, effects and control measures.
3. Disaster Management: Disaster Management Authority of India. Earthquake resistance buildings, flood diversion measures, tsunami warning system.

Unit II Environmental Microbiology

1. Environmental Microbiology: Introduction, scope, importance of environmental microbiology, structure of microorganisms-fungi, bacteria, virus, classification of microorganisms, microbial diversity. Role of microorganisms in air, water and soil for microbial qualities, environmental aspects of infectious diseases (water born diseases).
2. Microbial Isolation: Types of culture, sterilization and disinfection, techniques used of enrichment of culture, method of pure culture, preparation, maintenance and preservation of microbial culture (pour plate, streak plate and spread plate).
3. Applied Microbiology: Control of pest and disease by microorganism. Role of microbes in sewage (trickling filter, activated sludge process and oxidation pond process).

Unit III Environmental Biotechnology

1. Introduction: Definition and scope of biotechnology, biotechnological approach of environmental pollution, energy management and abatement bioremediation, reclamation and restoration.
3. Microbes and energy: Role of micro-organisms in energy and biomass production, production of ethanol, methane and hydrogen, biogas production.

Unit IV Research Methodology

1. Research Problem and Design: Research problem-selecting a problem–necessity of defining the problem–technique involved in defining a problem. Research design-need for research design; features of good design; important concepts relating to
2. Data Collection and Sampling: Data- primary and secondary; data collection: census and sample; sampling: need for sampling–types of sampling–principles of sampling; random and non-random sampling methods- sampling and non-sampling errors.


**Paper VIII Analytical Techniques for Environmental Monitoring**

**Unit I Chromatography**


3. Liquid Chromatography: Choice of solvents and stationary phases- characteristics of various stationary phases in chromatography, thin layer chromatography and paper chromatography.

**Unit II Spectrophotometry**

1. Absorption Spectroscopy: Principle, working and applications of various instruments.

2. UV-Visible spectroscopy, infrared spectroscopy, nuclear magnetic resonance.

3. Atomic absorption spectroscopy, flame photometer, nephelometer/turbidity meter.

**Unit III Electro Chemical Techniques**

1. Electro Chemical Techniques: Introduction, types of electro chemical technique, principle, instrumentation and application of polarography in environmental chemical analysis.

2. Aniodic stripping, voltametry with its application in environmental measurements, speciation of heavy metals like copper, cadmium, mercury, nickel and arsenic in natural water system.

3. Ion Selective Electrodes: Basic principles, classification of electrodes, measurement methods, instrumentation and application in the analysis of fluorides, nitrates, cyanides, ammonia, sulfides. Redox potential measurement and its significance in environmental monitoring.
Unit IV Modern Techniques and Environmental Statistics

1. Modern Instrumental Techniques: Atomic mass spectrometry, molecular mass spectrometry, mass spectrometric applications in environmental analysis, radiochemical analysis, inductively coupled plasma, x-ray diffraction.
2. Errors, types of errors, minimization of errors, accuracy, precision, significant figures, correlation coefficient and regression.
3. Mean, mode, median, range, standard deviation, relative deviation and arithmetic problems.

References

3. Microbiology: P. D. Sharma (Rastogi publication Meerut)
7. Applied Microbiology: Vimta Kale & Kishore Bhusari (Himalaya Publishing House, Mumbai)
15. Instrumental Analysis: Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952
17. Instrumental Analysis: Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000
18. Instrumental Methods: V. B. Borade (Nirali Prakashan, Mumbai)
24. Environmental Biology: P. D. Sharma (Rastogi Publications), Meerut

PSCENVP03
Practical III
Ecology and Microbiology

Ecology:
1. Qualitative and quantitative estimation of Phytoplankton.
2. Qualitative and quantitative estimation of Zooplankton.
3. Study of Macrophytes of lakes and Study of adaptive characteristics.
4. Estimation of Primary Productivity by light and dark bottle method.
5. Estimation of primary productivity of grasses by Harvest method.
6. Analysis of local lake with special reference to their conservation and management.
8. Bioremediation of contaminated soil site by heavy metals with plants.
9. Effects of bioremediation on plants physiology (stomata, xylem, phylum).
10. Thermal study of water bodies with respect to Temperature, pH, free CO₂, dissolved oxygen, acidity, alkalinity.
11. Study of Eutrophication of water bodies with respect to
   i. Total Nitrogen by Kjeldhal method.
   ii. Total Phosphate by Stannous chloride method.
12. Classification water bodies on the basis of Nitrogen, Phosphorous ratio for Oligotrophic, Mesotrophic and Eutrophic conditions.
13. Comparative study of fresh water body and eutrophic water body for the following parameter:
   i. Dissolved Oxygen
   ii. Phytoplanktons
   iii. Zooplanktons
15. Determination of Bulk Density of forest floor and wasteland.
16. Determination effect of Industrial water on river bed (clay sand, silt, bacteria and fungi).

Environmental Microbiology:
17. Isolation of bacteria from soil, water and air.
18. Collection and handling of water sample for bacterial analysis with respect to:
   i. Standard plate count at 37 °C.
ii. Coliform count by MTFT and MPN.
iii. Membrane Filtration Technique for coliform.
19. Estimation of DNA from biological material (germination of weed grass, animal tissue by U.V. spectrophotometer)

PSCENVP04
Practical IV
Air and Noise Analysis

Air Analysis:

1. Determination of Sulphur dioxide (SO$_2$) in ambient air by West and Geake method.
2. Determination of oxides of Nitrogen (NO$_X$) in ambient air by Jacob Hochheiser (Sodium Arsenite method)
3. Determination of Ammonia in ambient air.
4. Determination of ground level Ozone in ambient air.
5. Determination of CO in ambient air.
6. Determination of Suspended Particulate Matter (SPM) in ambient air.
7. Determination of Respirable Suspended Particulate Matter (RSPM) in ambient air.
8. Determination of Air Quality Index.
10. Determination of Sulphation rate by Lead Peroxide method.
12. Determination of trace metal in ambient air.
13. Air pollution study with respect to vegetation:
   i. Estimation of total dust.
   ii. Collection and analysis of plant leaves from heavy traffic area for estimation of trace metal.
   iii. Effect of air pollutants on plants with respect to leaf injury such as chlorosis, necrosis, silvering, banding.

Noise Sampling:
14. Determination of noise level in different areas viz: residential, commercial, industrial and silence zone and comparison with ambient standard.

References

2. Water and wastewater Analysis. National Environmental Engineering Research Institute (NEERI), Nagpur