GONDWANA UNIVERSITY

GADCHIROLI

National Education Policy 2020

FACULTY OF SCIENCE AND TECHNOLOGY

Syllabus

M.Sc. I Semester I and II

Program: FYPGP

PG Course: Environmental Science

With effect from 2023-2024

Scheme of teaching and examination under semester pattern NEP2020 for M.Sc. Program (Semester I&II) in Environmental Science

SEMESTER I

Major and Elective Paper, Code	Theory / Practical	Teaching Scheme			Credit	Examination Scheme					
		Hours/ week				Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
Major I, PMENVT01	Paper I	4		4	3	4	80	20	100	40	
Major II, PMENVT02	Paper II	4		4	3	4	80	20	100	40	
Major III, PMENVT03	Paper III	4		4	3	4	80	20	100	40	
Elective, PEENVT04 (Paper 1, 2, 3,4 &5)	Paper IV	4		4	3	4	80	20	100	40	
Practical I, PMENVP01	Practical 1		4	4	2	4	75	25	100		50
Practical II, PMENVP02	Practical 2		4	4	2	4	75	25	100		50
Research Methodology, RMENVT05	Paper V	4		4	3	4	80	20	100	**40**	
Seminar	Theory	--	--	--	1	1	--	50	50	--	--
TOTAL		**20**	**8**	**28**	**20**	**29**	**550**	**200**	**750**	**200**	**100**

SEMESTER II

Major and elective Paper, Code	Theory / Practical	Teaching Scheme			Credit	Examination Scheme					
		Hours/ week				Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
Major I, PMENVT06	Paper VI	4		4	3	4	80	20	100	40	
Major II, PMENVT07	Paper VII	4		4	3	4	80	20	100	40	
Major III, PMENVT08	Paper VIII	4		4	3	4	80	20	100	40	
Elective, PEENVT09 (Paper 1, 2,3, 4&5)	Paper IX	4		4	3	4	80	20	100	40	
Practical III, PMENVP03	Practical 3	--	4	4	2	4	75	25	100	--	50
Practical IV, PMENVP04	Practical 4	--	4	4	2	4	75	25	100	--	50
OJT/FP (On Job Training, Internship/Apprenticeship/Field Project), OJT, ENVT10	Paper X	4	--	4	3	4	80	20	100	40	--
Seminar	Theory	--	--	--	1	1	--	50	50	--	--
TOTAL		**20**	**8**	**28**	**20**	**29**	**550**	**200**	**750**	**200**	**100**

GONDWANA UNIVERSITY, GADCHIROLI

National Education Policy

2020

M.Sc. I (Semester I)

Environmental Science

Distribution of Courses for M.Sc. Semester I

M.Sc. Semester I		
Sr.No.	**Course Title, Code**	**Paper Title (Total Credits=20)**
Major Papers: Credits:3X3=9		
1	Major Paper I (PMENVT01)	Fundamentals of Environmental Science (3)
2	Major Paper II, (PMENVT02)	Chemical aspects of environmental science (3)
3	Major Paper III (PMENVT03)	Ecology (3)
Elective Paper IV, (PEENVT04) (Any One): Credits:3X1=3		
4	Elective (IV), Paper 1	Environmental Pollution (3)
5	Elective (IV), Paper 2	Fundamentals of Atmospheric Science (3)
6	Elective (IV), Paper 3	Physical Environment (3)
7	Elective (IV), Paper 4	Elements of climate science (3)
8	Elective (IV), Paper 5	Freshwater Ecology (3)
Paper V, Credits:3		
9	Research Methodology, Paper V, RMENVT05	Research Methodology (3)
10	**Seminar**	**Credit (1)**
11	**Practical I**	**PMENVP01: Water and Soil Sampling and Analysis (2)**
12	**Practical II**	**PMENVP02: Ecology and Research Methodology(2)**

M.Sc. I (Semester II)

Environmental Science

Distribution of Courses for M.Sc. Semester II

M.Sc. Semester II		
Sr.No.	**Course Title**	**Paper Title (Total Credits=20)**
Major Papers: Credits:3X3=9		
1	Major Paper VI (PMENVT06)	Environmental Sampling and Analysis (3)
2	Major Paper VII (PMENVT07)	Natural Resources: Conservation and Management (3)
3	Major Paper VIII, (PMENVT08)	Analytical Techniques for Environmental Monitoring (3)
Elective Paper IX, (PEENVT IX) (Any One): Credits:3X1=3		
4	Elective (IX), Paper 1	Paper 1 Microbiological aspects of environment 3)
5	Elective (IX), Paper 2	Paper 2 Environmental Toxicology (3)
6	Elective (IX), Paper 3	Paper 3 Forest Ecology (3)
7	Elective (IX), Paper 4	Paper 4 Environmental Issues and Solutions (3)
8	Elective (IX), Paper 5	Paper 5 Environmental Sustainability (3)
9	**Practical III, PMENVP03**	**Air Sampling and Analysis (2)**
10	**Practical IV, PMENVP04**	**Environmental Biology and Sustainability (2)**
Paper X, Credits:3		
9	**OJT/FP** (On Job Training, Internship/Apprenticeship/Field Project), **Paper X, OJT ENVT10**	**Paper 10, OJT/FP (3)**
10	**Seminar**	**Credit (1)**

Note- 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 five 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 6 hours duration 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 universitylevel with external examiners.
- The examinee shall be required to pass in theory and practicals separately.
- 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)		
1	One major experiment	30 marks
2	Two minor experiments	30 (15 marks each)
3	Certified practical record book	05 marks
4	Certified tour report/field diary	05 marks
5	Viva-Voce	10 marks
	Total	**80 marks**

M.Sc. Environmental Science

Semester I

Major Paper

Paper I

PMENVT01: Fundamentals of Environmental Science

Unit I: Basics of Environmental Science

1. Atoms and Molecules: Origin of the Universe. The three era – radiation, matter and life era. Nucleosynthesis. Life cycle of a star. Distribution of elements. Big bang theory. Solar system. Aura and Meteorite.

2.Earth: Formation of the earth. Structure of the earth. Composition of crust. Mantle, coreand earth as a whole. Differentiation of elements. Origin of life. Evolution of human being. Earth and its special features. Evolutions of India.

3.Basics of Environmental Science: Definition, History of Environmental science: Conservation and environmentalism. Key Concepts in Environmental Science, General principles. Components: Atmospheric sciences, Ecology, Environmental chemistry, Geosciences, Theoretical &Applied aspects of Environmental Science. Need and Scope of Environmental Science.

Unit ll: Earth surface processes

1. Atmosphere: Evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface,

2.Earth system processes: Movement of lithosphere plates; major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, continental collision and mountain formation with specific example of the Himalaya.

3. Land surface processes: Ocean–land interface; fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.

Unit III: Environmental Problems

1. Global Warming: Definition. Green house gases. Greenhouse gases in the atmosphere – sources and their impacts on health and agriculture, levels and

mechanisms of action. Global warming potential of GHG's. Pre-industrial and existing atmospheric CO_2 concentration. Green house effects and climate change, consequences of greenhouse effect and global warming. Control measures. Carbon credits, CO_2 emissions: local and global scenario.

2.Global Climate change: Science of climate change, Global climate change process. Earth's carbon reservoirs and carbon cycle, Effects: Rise in earth's temperature; effects on forests, agro-ecosystems; desertification, freshwater ecosystems, oceans; sea level rise; melting of polar ice and glaciers; rainfall patterns; extreme events, socio-economic and publichealth consequences. India's response to climate change. Intergovernmental Panel for Climate Change (IPCC) and its role.

3.Ozone Layer: Significance. Measurement of ozone layer (Dobson unit). Formation. Mechanism of ozone depletion. Effects of ozone layer depletion on man, plants and biotic communities. Status of ozone layer, present research and techniques to protect ozone layer. Global debates on Ozone layer protection

UNIT- IV: Sustainable development

1. Sustainability and Sustainable Development: Sustainability theory, sustainability and society (social justice, development, economy). Concepts and principles of sustainable development. Case studies.

2.Ethics and Landmark Judgments: Value education and community, corporate social responsibility. Environmental Movements related to Environment – Sacred groves, Bishnoi tradition, Chipko movement, Apiko movement, Tehri dam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Environmental ethics: issues and solutions

3.Sustainable development action plan: Agenda-21; UNEP programmes towards sustainable development: Sustainable development goals. Transforming our world: the 2030 Agenda for Sustainable Development. World summit on sustainable development (WSSD 2002). List of actions in everyday life.

Paper II

PMENVT02: Chemical aspects of environmental science

Unit I Fundamentals of Chemistry

1. Fundamentals of Chemistry: Classification of elements, Valency: Concept, importance and applications, basic concepts of colorimetry, Lambert's law, Beer's law, molecular weight, equivalent weight, principles of colloidal chemistry, emulsions: applications, Surface Chemistry- 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 equilibrium, chemical reactions, solubility product, stoichiometry.

Unit II Basic Concepts of Environmental Chemistry

1. Acid Base Equilibria: Acid -Base titration, Theory of acid–base indicators; selection of indicators and their limitations, alkalinity and acidity, the carbonic acid system, buffering in water system.

2. Solubility Equilibrium: Solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

3. Oxidation Reduction Equilibrium: Redox reactions, Applications of Redox Reaction, Redox potential, measuring redox potential. Green chemistry for sustainable future.

Unit III Aquatic Chemistry

1. The Solvent Water: Structure of water. Hydrological cycle, distribution of water, sources and uses of water, physico-chemical characteristic of water, Eh-pH diagram.

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

3. Metals in Aqueous Solution: Protons and metal ions, hydrolysis of metal ions, chelation.

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.

2. Properties of Soil: Physicochemical properties of soil, major soil types in India and Maharashtra. Soil survey.

3. Soil Fertility: Macronutrients and micronutrients in soil, nitrogen pathways and NPK in soil, biofertilizer and humus.

Paper III

PMENVT03: Ecology

Unit I Fundamentals of Ecology

1. Introduction to Ecology: Origin of term, definition, objectives of ecology, subdivision of ecology, scope of ecology.

2. Abiotic Environmental Factors: Liebig's law of Minimum, Shelford's law of Tolerance, principles of tolerance, factor compensation and ecotypes, combined concept of limiting factor. Biotic potential and carrying capacity.

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 (O2 and CO2), concentration of biogenic salts, ecological classification of fresh water habitat (standing water or lentic, running water or lotic).

2. Planktons: Phytoplankton and zooplankton, benthos and periphytons as an indicator of water quality and their qualitative and quantitative study. Beneficial and harmful effects of plankton.

3. Biotic Interactions: Positive interactions-mutualism, commensalism, protocooperation, negative interactions-exploitation, amensalism, competition.

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.

3. Ecological Succession: Definition, kinds, process, patterns of succession-xerosere, hydrosere and significance of ecological succession.

Unit IV Ecosystem and Eco-stability

1. Ecosystem: Concepts, structure, functions and types of ecosystem, abiotic and biotic components. Energy flow and energy dynamics of ecosystem. Food chains, food web, trophic level, ecological pyramids.

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.

3. Concept of Eco-stability: Ecological resistance, ecological resilience and ecological perturbation, natural and anthropogenic impact on ecosystem and organism. Plant invasion, ecosystem restoration (climax). Ecological indicators.

Elective Paper (IV)

PEENVT04: Paper 1 Environmental Pollution

Unit I Air Pollution

1. Basics of Air Pollution: Definition, sources and classification of air pollutants (primary and secondary pollutants), effects of air pollutants on human beings, plants, animals, materials and climate. National Ambient Air Quality Standard.

2. Vehicular Pollution: Major vehicular pollutants, effects and its control strategy. Euro norms I, II, III, IV, VI Bharat stage standard.

3. Photochemical Smog: Types, theory of formation, effects of photochemical smog. London and Los Angeles smog. World's most polluted cities, Urban heat island phenomenon.

Unit II Water Pollution

1. Basics of Water Pollution: Introduction, nature and types of water pollution. Classification of water pollutants. Effects of water pollution, control measures.

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

3. Oil Pollution: Introduction, sources, effects, control measures. Heavy metals pollution. Eutrophication-causes, consequences and control.

Unit III Soil Pollution

1. Soil Pollution: Definition of soil pollution, sources, consequences and control measures.

2. Soil Deterioration: Causes of soil degradation, reclamation of degraded soil. Bioremediation and Phytoremediation.

3. Soil Erosion: Definition, causes, control methods.

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.

Elective Paper (IV)

PEENVT04

Paper 2 Fundamentals of Atmospheric Science

Unit I Basic Concepts of Atmospheric Science

1.Atmospheric Science: Composition, structure and evolution of atmosphere. Modern views regarding the structure of atmosphere, segments of environment, earth radiation balance, particles, ions, radionuclides in atmosphere.

2.Basics of Atmosphere: Atmospheric aerosols: Chemical composition, transport and sinks, residence times of aerosols, First and second law of thermodynamics, heat transfer process. Radiation, conduction and convention.

3.Reactions in Atmosphere: Reactions including oxides of nitrogen and oxides of sulphur, hydrocarbons.

Unit II Climatology

1.Basics of Climatology: Definition and scope of climatology. Aims and objectives of climatology. Weather and climate. Insolation, factors affecting distribution of insolation and heat budget. Depletion of solar radiation. Evaporation, factors affecting rate of evaporation.

2.Meteorological Processes: Condensation, forms of condensation: dew, frost, fog, mist, smog and cloud. Clouds, classification of clouds, role of clouds in weather forecasting.

3.Applied Climatology: Atmospheric disturbance. Cyclones and anticyclone. Tropical disturbance and their environmental significance. Climate and natural vegetation, climate and agriculture, climate and health, climate and diseases, climate and urban planning.

Unit III Meteorology

1.Basics of Meteorology: Definition, scope, aims and objectives of meteorology. Primary meteorological parameters and their measurements-temperature, wind direction and wind speed. Secondary meteorological parameters and their measurements: humidity, relative humidity, absolute humidity, pressure and solar radiation.

2.Lapse Rate and Temperature Inversion: Definition, types of inversion and effects of inversion. Atmospheric stability, stability classes. Mixing height and ventilation coefficient. Plume behavior. Stack height. Effects of meteorological parameters on environment.

3.Applied Meteorology: Collection and analysis of wind data, wind roses, construction of wind roses and its interpretation. Pollution roses.

Unit IV Global Warming, Ozone Depletion and Climate Change

1.Green House Effect: Introduction, green house gases, green house effect, global warming, effects on environment and control measures.

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.

3.Climate Change: Implications of climate change, monitoring, assessment, research and prediction programme. El Niño and La Niña phenomenon.

Elective Paper (IV)

PEENVT04

Paper 3 Physical Environment

Unit I

Earth's interior: Different zones in the Earth's interior and their composition. The Earth's Magnetic Field - Magnetic reversal and magnetic anomaly. Continental Drift Theory. Theory of isostasy and global isostatic adjustment. Rock cycle, Introduction to major rock types. Physical weathering, chemical weathering and their types Folds and faults, major types of folds and faults.

Unit II

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

Unit III

Earth Process and Hazards: Catastrophic Geological Hazards, Study of Floods, Land Slides, Earthquakes and Types of seismic waves and their role in the study of Volcanism, Tsunami and Avalanche. Study of Topographic and Environmental Maps.

Unit-IV

Factors affecting landform development. Fluvial system - Factors affecting stream erosion and deposition, Erosional and depositional landforms. Underground water system - Water table, landforms formed by ground water action. Aeolian system - Mechanism of wind erosion, erosional and depositional landforms. Glacial system - Mechanism of glacial erosion, erosional and depositional landforms.

Elective Paper (IV)

PEENVT04

Paper 4 Elements of climate science

Unit I: Basics of climate

Atmospheric structure and composition, Observations and theory of the general circulation of the atmosphere, Global energy balance, Radiative processes in the atmosphere, the greenhouse effect, natural and anthropogenic climate change, waves in the atmosphere, clouds, weather systems, tropical dynamics and monsoons, ocean circulation.

Unit II: Climatic Systems and Variations

Global Climate System, Causes for Modern Climate Change, Internal Variability: Ocean-Atmosphere Variability, Ocean Currents, External Climate Forces: Greenhouse Gases, Orbital Variations, Solar Fluctuations, Volcanism, Plate Tectonics, Evidence and Measurement of Climate changes

Unit III: Consequences and Challenges

Impacts on Life, Vegetation, Fauna, Glaciers and Ice Sheets Melting, Sea Level Changes, Economics of Climate Change, Climate Change and Water Scarcity, Coastal Ecosystem and Vulnerability, Threats to Forest and Biodiversity, Agriculture and Food Security, Energy Generation and Climate Change Mitigation.

Unit IV: Climate Change: Policies and Mitigation

India: National Action Plan on Climate Change (NAPCC) , State Action Plan on Climate Change (SAPCC) , National Adaptation Fund on Climate Change (NAFCC), Long Term Ecological Observatories (LTEO) Programme, Findings and Efforts by NASA and ISRO, Carbon Emissions Reduction Technologies, Climate Change Research, Climatology Journals and Top Institutions, Governance for Climate Change, The Economics of Carbon Mitigation: Integrated Assessment Models (IAM)

Elective Paper (IV)

PEENVT04

Paper 5 Freshwater Ecology

Unit I: Natural history of freshwater biota

Natural history of freshwater biota: Attached algae, phytoplankton, and macrophytes, freshwater environments: springs, streams, rivers, wetlands, lakes, reservoirs and estuaries, Natural history of freshwater biota: Riparian vegetation and fungi (Ecological stoichiometry, nutritional ecology), Natural history of freshwater biota: Invertebrates and Vertebrates, species interactions in freshwaters (Ontogenetic niches)

Unit II: Characteristics of aquatic region

Lakes - Origin and classification, ecological zonation, thermal stratification, water circulation, physical and chemical characteristics, Diversity of aquatic habitats, hydrologic cycle, Aquatic food webs including microbial loop; trophic cascade, Phytoplankton – diversity and models of nutrient-limited growth, paradox of plankton; a general account of zooplankton, A general account of benthic and periphytic communities, Characteristics of running water habitats; river continuum concept, A general account of estuaries and wetlands

Unit III: Impacts on aquatic systems

Species impacts on ecosystems (non-trophic, ecological engineering), Oligo-trophication and eutrophication of freshwaters (Energy sources, trophic transfer efficiency and the distribution of trophic level biomass), Invasions in fresh waters, Disease ecology in fresh waters, Global change: impacts of warming, land use, and altered precipitation regimes on freshwaters,

Unit IV: Conservation of aquatic ecosystem

Chemicals in freshwater ecosystems, drivers of dissolved oxygen concentrations including photosynthesis and respiration, Carbon cycling, leaf litter breakdown, Nutrient use and remineralization by aquatic organisms, Restoration and resilience in fresh waters. lake ecosystem services and management, Convention on wetlands of international importance (Ramsar Convention); National programmes in wetland conservation.

M.Sc. Environmental Science

Semester I

Paper V

RMENVT05: Research Methodology

Unit I: Research Methodology

1.Research Methodology: An Introduction, meaning of research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Importance of Knowing how Research is Done,

2. Defining the Research Problem: What is Research Problem? Selecting the Problem? Necessity of Defining the Problem.

Unit II: Research Design

1. Meaning of Research Design: Need for Research Design, Features of a Good Design, Important Concept Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs.

2. Sampling Design: Census and Sample Survey, Implications of a sample Design, Steps in Sampling Design, Criteria for Selecting a Sampling Procedure, Characteristics of a Good Sample Design.

Unit III: Methods of Data Collection

1. Collection of Primary Data: Collection of Data through Questionnaires, Collection of Data through Schedules, Different between Questionnaires and Schedules,

2. Selection of Appropriate Method for Data Collection: Case Study Method, Appendices (i): Guidelines for Constructing Questionnaires/ Schedule, (ii): Guidelines for Successful Interviewing, (iii): Difference between Survey and Experiment. Concept of ANOVA-examples on one way and two-way classification.

Unit IV: Interpretation and Report Writing

1. Interpretation and Report Writing: Meaning of Interpretation, Why Interpretation? Technique of Interpretation: Precaution in Interpretation, Significance of Report Writing.

2. Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precaution for Writing Research Reports. IPR in India (Patent, Trademarks, Copyrights, Trade secrets), International patent system.

M.Sc. Environmental Science

Semester I

Practical I

PMENVP01: Water and Soil Sampling and Analysis

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

2. Weighing capacity and sensitivity of balance care and use of balance.

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.

6. Examination of water quality with respect to following physical parameters.

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 parameters: Acidity, Alkalinity, Hardness, Chlorides.

8. Determination of Dissolved Oxygen and Calculation of Percent Saturation.

9. Measurement of Solar Constant.

10. Determination of wind velocity by three cups Robinson's anemometer.

11. Determination of relative humidity by Psychrometer.

12. Determination of current voltage characteristics of Solar Cell.

13. Study of Solar characteristics of Photovoltaic cell.

14. Soil Sampling in agriculture field and wasteland by quartering method.

15. Analysis of organic forming soil for calculating following physical parameters.

i) pH ii) Bulk Density iii) Texture iv) Water holding capacity v) Specific gravity vi) Conductivity vii) Moisture

16.Analysis of organic forming soil for chemical parameters.

i) Acidity ii) Alkalinity iii) Chlorides iv) Hardness v) Organic Carbon vi) Organic matter

17. Determination of Sulphate by Barium Chloride method

18. Identification of different Igneous, sedimentary rocks and metamorphic rocks.

M.Sc. Environmental Science

Semester I

Practical II

PMENVP02: Ecology and Research Methodology

1. Determination of light intensity, temperature, flow rate and discharge rate in freshwater ecosystem.

2. Determination of pH, conductivity and transparency in freshwater ecosystems.

3. Analysis of free CO2 in water.

4. Determination of total alkalinity in water.

5. Estimation of dissolved oxygen in water by Winkler's method.

6. Estimation of calcium and magnesium concentration in water / estimation of hardness in water.

7. Estimation of sodium and potassium in a lake.

8. Estimation of nitrate content in a lake.

9. Estimation of phosphate content in a lake.

10. Estimation of primary productivity in freshwater systems by light and dark bottle method.

11. Analysis of phytoplankton communities in lotic and lentic ecosystems.

12. Study of periphyton communities in lotic ecosystems.

13. Studies on Macrophyte community composition in freshwater ecosystems.

14. Qualitative and quantitative studies of zooplankton community in freshwater systems.

15.Quantitative estimation of plankton by Sedgewick Rafter Counting Cell/Chamber

19)Undertaking surveys and collection of field information on environmental components

22)Preparation of questionnaire on socio-economic impacts and impact of technology on environment in the study area

25) Data presentation by frequency tables, diagrams and graphs.

26) Calculations based on measures of central tendency.

27) Calculations based on measures of dispersion.

28) Calculations based on relative measure of dispersion.

29)Calculations based on measures of skewness and kurtosis.

30) Analysis of software data used for basic statistical analysis.

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M.Sc. Environmental Science

Semester II

Major Paper

PMENVT06: Paper VI 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

1.Soil Sampling: Types of soil survey, soil survey methods, collection of soil sample, procedure for soil sampling. Sample preservation.
2.Sample Preparation: Preparation of soil sample for various analyses.
3.Soil Analysis: Soil pH, bulk density, water holding capacity, available phosphorous, available potassium and available nitrogen, organic carbon.

Unit IV Noise Sampling

1.Acoustical Concepts: Nature of sound, sound propagation in air, absorption of sound in air, decibel scale.
2.Sampling of Noise: Site identification, methodology of noise level measurement, instrumentation (sound level meter), Ln, Ld and Ldn. Vehicular noise measurement techniques.
3.Noise and Environment: Effects of meteorological parameters on noise propagation, occupational health and noise, noise exposure levels and standards, ambient air standards with respect to noise in India. Firecrackers and noise.

Paper VII

PMENVT07: 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 and conservation. Wildlife resources, water resources, food and agriculture resources of India. Energy consumption pattern in India.
2.Mineral Resources: Importance of minerals, formation of mineral deposit, mining of minerals, consequences of over exploitation of minerals and conservation of minerals.
3.Conventional Energy: Coal, oil and natural gas, mode of formation. Composition, impact of overuse of fossil fuels on environment.

Unit II Non-conventional Energy

1.Solar Energy: Solar energy collectors, principles of conversion of solar energy in heat, flat plate collectors- liquid air collector, advantages and disadvantages.
2.Solar Concentrator: Types of solar concentrators, Electricity generation from solar energy (photovoltaic).
3.Applications of Solar Energy: Solar distillation, solar pump, solar furnace, solar cooking, construction. Detail impacts of solar energy on environment.

Unit III Hydroenergy

1.Hydal Energy: Turbine and generators for small scale hydroelectric generation-bulbturbine, tube turbine, advantages and disadvantages.
2.Tidal Energy: Basic principle of tidal energy, components of tidal power plant, operation method, advantages and disadvantages.
3.Ocean Thermal Electric Conversion (OTEC): Basic principles, method of OTEC (open cycle, closed cycle), 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.
3.Biomass: Biomass conversion-wet and dry process, biogas generation.

Paper VIII

PMENVT08: Analytical Techniques for Environmental Monitoring

Unit I Chromatography

1.Chromatography: Definition of the term chromatography-theory of chromatographic separation, stationary and mobile phases, classification of chromatographic separations.
2.Gas Chromatography: Instrumentation-criteria for the choice of mobile and stationary phase. Detectors–Flame Ionization Detectors, Electron Capture Detectors andThermal Conductivity Detectors. Advantages of Gas Chromatography coupled with Mass Spectrometry (GC-MS).
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.Anodic stripping voltammetry with its application in environmental measurements, speciation of heavy metals like copper, mercury in natural water system.
3.Ion Selective Electrodes: Basic principles, classification of electrodes, measurement methods, instrumentation and applications in the environmental analysis. Redox potential measurement and its significance in environmental monitoring.

Unit IV Modern Techniques and Environmental Statistics

1.Modern Instrumental Techniques: 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.

Elective Paper IX

PEENVT09:Paper1 Microbiological aspects of environment

Unit I 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 borne 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 II Biofertilizer

1.History of biofertilizers, sources of nitrogen and the importance of biofertilizers, description and characteristics of biofertilizers-Rhizobium, Azotobacter, Blue Green Algae, Azospirillum, Azolla, phosphate solubilizing microorganisms, VAM)
2.Biofertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control.
3.Biofertilizer application technology, constraints in the commercialization of biofertilizer technology

Unit III Environmental Biotechnology

1.Introduction: Definition and scope of biotechnology, biotechnological approach of environmental pollution, energy management and abatement bioremediation, reclamation and restoration.
2.Applied Biotechnology: *In-situ* and *Ex-situ* bioremediation, microbes used in pollution mitigation, environmental biotechnology and sustainability, bio-control agents- bio-pesticides, bio-insecticide, mushroom cultivation and vermiculture. Bioethics and biosafety.
3.Microbes and energy: Role of micro-organisms in energy and biomass production, production of ethanol, methane and hydrogen, biogas production.

Unit IV Microbial services for environmental restoration

1.Microbial services in green house gases mitigation, natural resource management and restoration. Ecology. Microbial ecology of green house gas (methane) producing and consuming bacteria from different ecosystems.
2. Impact of different environmental drivers on ecologically beneficial microbial community and their biomass. Beneficial microbial services in wasteland reclamation and restoration of

marginal lands

3. Microbial biomass as soil fertility index of different agriculture and forest ecosystems

Elective Paper IX
PEENVT09: Paper 2 Environmental Toxicology

Unit I Basic Principles in toxicology

1. Principles of Environmental Toxicology and the Dose-Response Relationship, Concept of toxicants and xenobiotics, Animal management in toxicological evaluation; Statistical concepts of LD50; Frequency response and cumulative response; Biological and chemical factors that influence toxicity. Pollution of the ecosphere by industries; Global dispersion of toxic substance; Dispersion and circulating mechanisms of pollutants; degradable and non-degradable toxic substances; food chain. Influence of ecological factors on the toxicity, Eco-system influence on the fate and transport of toxicants.

Unit II Mechanisms of Toxicity

Biotransformation, Phase I and Phase II Types Reactions, Target Organs and Mechanisms of Actions, Bioconcentration, Bioaccumulation, Biomagnification and Bioavailability, Organ Specific Toxic Effects, Neurotoxicological Effects of Environmental Pollutants, Toxicity of Pesticides, Enzymatic Reactions, Nerve Gases, Toxicity of Metals and Miscellaneous Industrial Chemicals, Carcinogenesis and Mechanisms, Human Carcinogens, Teratogens and Mechanisms of Actions

Unit III Effects of toxicants

Environmental Fate and Sources of Pollutants, Carcinogenic & Genotoxicity Pollutants and Their Effects, Ecotoxicology, Biomarkers, Biochemical Effects and Mechanisms of Toxicity of Pollutants, Physiological and metabolic effects of toxicants, e.g.1) VOC and organic solvents, used in industry 2) Heavy metals such as Hg, Pb, AS, Cd etc. Neurotoxicological Effects of Environmental Pollutants, Factors determining adverse effects of toxicants: Intrinsic toxicity, dose, exposure conditions, response of host, Influence of ecological factors on the toxicity, Eco-system influence on the fate and transport of toxicants.

Unit IV: Evaluation of toxicity

Occupational Toxicology & Exposure Limits, Parameters of toxicity testing: Acute toxicity, Chronic toxicity TU, ICp, TER, NOEC, LOEC, LC 50, LD50, TLm, Aquatic toxicity tests; Statistical tests; Toxicity Testing, and ADME I (Absorption, Distribution, Metabolism and Excretion), ADME II (Toxicokinetic and Metabolism), Toxicity testing methods: Using test animals, Non animal toxicity test methods: In vitro cell and tissue-based method, In silico method and integrated testing method, Toxicity test: Range finding, Screening, Definitive toxicity test, Interaction of toxicants in combination: Additive, synergistic and antagonistic effects, Alternatives to animal tests, Ecological and Human Health Risk Assessment, Information management system in eco-toxicology.

Elective Paper IX
PEENVT09: Paper 3 Forest Ecology

Unit I: Vegetation Ecology

Functional relationships between soil, climate, flora and fauna in forest ecosystems, distribution of forests w.r.t. nutrient availability, soil moisture, disturbance, climate and geographical location. Structure and function of forest vegetation, variation in time and space. forest production, decomposition, disturbances (especially forest fire), succession, post fire development, tree species ecology, forest types, forest floor, vegetation and epiphytes. differences between natural and managed forests and restoration of forest ecosystems based on natural variation.

Unit II: Abiotic factors and interactions

Soil science and meteorology, basic soil factors important for the composition and growth of forests, forest floor vegetation composition and growth(geology, hydrology, soil physics, soil chemistry, soil types, decomposition, nitrogen dynamics),Effects of forest management operations and other environmental impacts on soil ecosystems, Meteorology (Forest meteorology concepts and methods, climatic factors affecting forest growth, dynamics and damages),Energy exchange between vegetation and the atmosphere**,** micro-meteorological processes in forest terrain.

Unit III: Biotic factors and interactions

Forest animal ecology, entomology, and mycology, composition of fauna, adaptions to climates and the impact of animals on forest structure and function, including their role as disturbance factors and pests. Entomology- the function of insects in forest ecosystems, forests and population biology, important pest insect, invasive species and conservation. Mycology -the function of fungi in forests, nutritional strategies, dispersal ecology, decomposers, parasitic fungi, mycorrhizae, important pest fungi, lichen, indicator species and nature conservation.

Unit IV: Research in Forest Ecology

Relationships between soil, climate, regeneration, production, disturbances, flora and fauna in forests, Natural and managed forests on different types of soils and with different disturbance regime, importance of forest fire and forest trees species role in the forest ecosystem, Impact of forest management on biodiversity and red-listed species, Case Studies on ecological problem regarding relationships between soil conditions, forest structure, forest floor vegetation and animal populations, planning, literature search, collection of field data, processing, compilation, critical analysis and evaluation of the results obtained.

Elective Paper IX
PEENVT09: Paper 4 Environmental Issues and Solutions

Unit I: Global Environmental Issues

Ozone Layer Depletion, Acid Rain and Its Spread, Desertification and Expansion, Greenhouse Effect and Global Warming, Climate Change and Current Issues, Energy Crisis and Issues, Genetically Modified Organisms, WTO and Environmental Issues, Species Loss and Human Impacts, E-Wastes and Global Generation, Food Crisis and Population, Biological Warfare and Future Threats, Eco-Terrorism and Issues, Issues Related to Shipping, Water Crisis and Future Conflicts, Population Explosion and Resource Crunch, Wastelands and Degradation

Unit II: Environmental Issues in India

Soil Erosion and Impacts on Production, Alkaline and Saline Soils, Industrial and Vehicular Air Pollution of Indian Cities, Water Quality Degradation of Indian Rivers, Groundwater Pollution and Its Consequences, Municipal Solid Wastes and Conflicts, Issues with Slums and Environmental Health, Droughts and Floods in India, Eutrophication Issues of Major Aquatic Ecosystems, Dams and Displacement Issues.

Unit III: National Efforts to Curb Issues

Citizen Participation in Environmental Decisions, Environmental Information System Network, Right to Information and Environment Protection, Policies and Laws on Environmental Protection, Ganga Action Plan and Recent Programmes, Strategies under Disaster Management Plan, Wasteland Development Programme, Fly Ash Utilization Policy, Rainwater Harvesting and Its Implementation.

Unit IV: International Efforts

Sustainable Development Goals and Solutions, Clean Development Mechanism, Carbon Emissions and Future Targets, Carbon Credits and Its Implementation, Carbon Sequestration and Programmes, Green Politics and Issues, Role of IUCN and UNEP, Important International Agreements

Elective Paper IX
PEENVT09: Paper 5 Environmental Sustainability

Unit I: Sustainability and development challenges

Definition of sustainability – Environmental, Economical and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development- Millennium Development Goals – Mindsets for Sustainability : Earthly, Analytical, Precautionary, Action and Collaborative– Syndromes of Global Change: Utilization Syndromes, Development Syndromes, and Sink Syndromes – Core problems and Cross Cutting Issues of the 21 Century - Global, Regional and Local environmental issues – Social insecurity - Resource Degradation – Climate Change – Desertification

Unit II: Approaches to Sustainable Development

History and emergence of the concept of sustainable development - Our Common Future - Stockholm to Rio plus 20– Rio Principles of Sustainable Development – Precautionary Principle- Polluter Pays Principle – Role of Civil Society, Business and Government -Natural Step- Peoples Earth Charter – Business Charter for Sustainable Development –UN Global Compact – Agenda 21. Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context – Rio Plus 20 - Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability

Unit III: Sustainable livelihood

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution – Combating Poverty -Millennium Development Goals, Indicators, Targets, Status and intervention areas - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

Unit IV: Sustainable socio-economic systems

Protecting and Promoting Human Health – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Urbanization and Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation – Sustainable Consumption and Production – Sustainable Mining - Sustainable Energy– Climate Change – Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

Practical III,

PMENVP03: Air Sampling and Analysis

1.Sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke Method)

2.Sampling and analysis of Nitrogen dioxide in ambient air (Modified Jacob and Hochheiser Method)

3.Sampling and analysis of Particulate Matter (PM10, PM2.5) in ambient air (Gravimetric Method)

4. Sampling and analysis for ozone in ambient air (Chemical Method)

5.Sampling and analysis for ammonia in ambient air

6.Determination of Settleable particles using dust fall jar apparatus.

7.Determination of Sulphation rate by Lead Peroxide method.

8.Construction and interpretation of wind roses and pollution roses.

10.Determination of trace metal in ambient air.

11.Determination of dry weight of municipal solid waste sample

12. Determination of wet weight of municipal solid waste sample

13.Determination of solid waste for physical parameters

14. Proximate analysis

a. Moisture (loss at 105°C for 1h)

b. Ash (residue after burning)

c. Fixed carbon (remainder)

15.Determination of Sulphate by Barium Chloride method and Spectrophotometric method.

16.Determination of Sodium and Potassium in water by Flame Photometer.

17.Determination of Iron by o-phenanthroline method and Spectrophotometric method.

18.Determination of Manganese by spectrophotometric method.

19.Determination of Fluoride by SPANDS method.

20.Determination of Copper by Solvent Extraction method and Spectrophotometric method.

21.Determination of Nickel by Solvent Extraction method and Spectrophotometric method.

22.Determination of phosphate by spectrophotometric method

Practical IV

PMENVP04: Environmental Biology and Sustainability

1.Estimation of phytoplankton from lake water sample

2. Estimation of zooplankton from lake water sample

3.Determination of vermicompost sample for organic carbon, organic matter, acidity

4. Determination of sludge for SVI

5. Determination of sludge for SDI

6. Determination of BOD of sewage treatment plant/ waste water sample

7. Determination of COD of sewage treatment plant/waste water sample

8. Isolation and enumeration of bacteria from soil, water and air sample

9. Detection of coliforms for determination of the purity of potable water

10. Ccollection and handling of water sample for bacterial analysis with respect to:

i.) Standard plate count at 37 0C.

ii) Coliform count by MTFT and MPN.

iii) Membrane Filtration Technique for coliform.

11.Finding the LC50 / LD50 dose of toxicant/ pollutant

10.Determination of the effects of pollution on the oxygen consumption of fish

11. Determination of sulphate of polluted waste water sample

12. Determination of phosphate of polluted waste water sample

13.Vegetation studies by line and belt transects and quadrates.

14.Estimating frequency, Density and Abundance of species from Forest/Grassland area.

15.Calculation of Shannon and Simpson's Index for community comparison.

16.Nutrients studies of forest floor- Analysis of forest floor for NPK

17.Determination of organic carbon/matter of forest floor

18.Estimation of moisture content of forest soil

19.Experimentation on Green audit of i) Water ii) Air iii) Noise iv) Solid waste v) Energy and e-waste

20.Analysis of sustainability indicators of forests, lake, ponds and rivers

Paper X

OJT, ENVT10: OJT/FP (On Job Training, Internship/Apprenticeship/Field Project)

A) Industrial training

Students are encouraged to undergo summer/winter in plant training in a suitable industry so as to get firsthand experience of corporate environmental management.

B) Project Work (Dissertation)

Project Work Instructions for Students

(Total marks: 100. Project work: 80 marks, internal: 20 marks)

Candidates will write a dissertation on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The dissertation must consist of review of literature and produce a deep insight of the subject on the basis of personal research. Dissertation work will be initiated at the start of M.Sc. I year (II nd semester). The students will undertake field work in terms of collection of data and surveys. The dissertation will have to be submitted for appraisal and acceptance by the University to the concerned college. The students should submit their dissertation in the following format.

Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study.

Chapter II: Methodology with Material and Methods: Description of the issue, methodology adopted for the study.

Chapter III: Experimental: Presentation of data collected and detailed analysis of results.

Chapter IV: Result and Discussion: Discussion on the data and results obtained and Presentation of method suggested to solve the problem.

Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation.

Bibliography or References: A list of references of cited in the text.

The dissertation should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their dissertation one month Before the final practical examination at the end of M.Sc. II year (IVth semester). The

dissertation will carry 100 marks. Assessment of the dissertation will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the dissertation shall be done by the external examiner appointed by the Gondwana University, Gadchiroli.

C) Study visits

i) National Environmental Engineering Research Institute (NEERI), Nagpur

ii) Remote Sensing Center, Nagpur

iii) Regional Meteorological Center, Nagpur

iv) Maharashtra Pollution Control Board, Nagpur

v) Industrial visits

D) Seminar

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

D) Field diary

The student shall prepare their field diary under the following heads

i) Issue on local/regional/national problem of environmental interest (Case Studies).

ii) About famous personalities in environmental movements.

iii) New Acts and Judgments of environmental interests.

E) Guest lecture series

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

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2. Environmental Pollution and Toxicology: M.K. Rao. Manglam Publishers & Distributors.

3. Environmental Pollution: Health and Toxicology: S.V.S. Rana. Narosa Publishing House.

4. Toxicology (1999): A.Sood, Sarup and sons New Delhi.

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