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

	Core Course	Ability Enhancement	Skill Based Course	Discipline specific Elective
SEM I	Core 1 Th. Paper 1 (4 Credits) (4 Hours/Week) PSENVT01-Environmental Chemistry	Seminar I (1 Credit) (2 Hours/Week)		
	Core 2 Th. Paper 2 (4 Credits) (4 Hours/Week) PSENV02- Fundamentals of Atmospheric Science			
	Core 3 Th. Paper 3 (4 Credits) (4Hours/Week) PSENV03- Ecology			
	Core 4 Th. Paper 4 (4 Credits) (4 Hours/Week) PSENVT04-Environmental Pollution			
	Practical Core Pr. 1 {Based on Core Th. 1 and 2} (4 Credits) (8 Hours/Week) PSENVP01-Water Sampling Techniques and Analysis			
	Practical Core Pr. 2 {Based on Core Th. 3 and 4} (4 Credits) (8 Hours/Week) PSENVP02-Water and Soil Analysis			

Total 25 Credits

P=Postgraduate; S=Science; ENV=Environmental science; Th=Theory; Pr=Practical,

	Core Subject	Ability Enhancement	Skill Based Course	Discipline Specific Elective
SEM II	Core 5 Th. Paper 5 (4 Credits) (4 Hours/Week) PSENVT05- Environmental Sampling and Analysis	Seminar II (1 Credit) (2 Hours/Week)		
	Core 6 Th. Paper 6 (4 Credits) (4 Hours/Week) PSENVT06- Natural Resources: Conservation and Management			
	Core 7 Th. Paper 7 (4 Credits) PSENVT07- Environmental Disaster, Environmental Biotechnology			
	Core 8 Th. Paper 8 (4 Credits) (4 Hours/Week) PSENVT08- Analytical Techniques for Environmental Monitoring			
	Pr. Core Pr. 3 {Based on Core Th. 5 and 6} (4 Credits) (8 Hours/Week) PSENVP03- Ecology and Microbiology			
	Pr. Core Pr. 4 {Based on Core Th. 7 and 8} (4 Credits) (8 Hours/Week) PSENVP04- Air and Noise Analysis			

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

Core	Theory / Practical	Teaching Scheme			Credit	Examination Scheme					
		Hrs/ week				Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
PSCENVT01	Paper 1	4	-	4	4	3	80	20	100	40	
PSCENVT02	Paper 2	4	-	4	4	3	80	20	100	40	
PSCENVT03	Paper 3	4	-	4	4	3	80	20	100	40	
PSCENVT04	Paper 4	4	-	4	4	3	80	20	100	40	
Practical I PSCENVP01	Practical 1	-	8	8	4	12*	80	20	100		40
Practical II PSCENVP02	Practical 2	-	8	8	4	12*	80	20	100		40
Seminar I	Seminar 1	2	-	2	1			25	25	10	
TOTAL		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**17**	**80**

*Practical examination of 12 hours duration spread over two days.

SEMESTER II

Core	Theory / Practical	Teaching Scheme			Credit	Examination Scheme					
		Hrs/ week				Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
PSCENVT05	Paper 5	4	-	4	4	3	80	20	100	40	
PSCENVT06	Paper 6	4	-	4	4	3	80	20	100	40	
PSCENVT07	Paper 7	4	-	4	4	3	80	20	100	40	
PSCENVT08	Paper 8	4	-	4	4	3	80	20	100	40	
Practical III PSCENVP03	Practical 3	-	8	8	4	12*	80	20	100		40
Practical IV PSCENVP04	Practical 4	-	8	8	4	12*	80	20	100		40
Seminar II	Seminar 2	2	-	2	1			25	25	10	
TOTAL		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**170**	**80**

*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)		
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

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.
3. Oxidation Reduction Equilibrium: Oxidation-reduction processes, 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, chelates.

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.

PSCENVT02

Paper II 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, radionucleiods in atmosphere.
2. Basics of Atmosphere: Mass and energy transfer across various inferences. Material balance. 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 Nino and La Nino phenomenon.

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.
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 (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.
3. Biotic Interactions: Positive interactions-mutualism, commensalism, protocoproratio, negative interactions-exploitation, amensalism, competitive.

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.

PSCENVT04

Paper IV 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, Bharat stage standard.
3. Photochemical Smog: Types, theory of formation, effects of photochemical smog. London and Los Angeles smog. 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.

References

1. Environmental Science: W. Cunningham and Saigo, McGraw Hill, New York.
2. A Textbook of Environment: Agrawal, Mcmillion publication, Mumbai
3. A Textbook of Geology: Purbeen Singh.
4. Air Pollution: M. N. Rao, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003
5. Air Pollution: A. C. Stern
6. Environmental Problems and solution: Asthana, S. Chand and company, New Delhi.
7. Environmental Chemistry: S. S. Dara, S. Chand and Company, NewDelhi 2002.
8. Fundamental Concepts of Environmental Chemistry: G.S. Sodhi, Narosa Publishing House, New Delhi, 2002
9. Environmental Education: V. K. Rao, R. S. Reddy, Commonwealth Publisher, New Delhi.
10. A Textbook of Environmental Science: R.N. Trivedi, Anmol Publications Private Limited, 1997
11. Man and Environment: P. R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi, 1997.
12. Environmental Studies: Kuashik and Kaushik, New Age International Publishers, 2004.
13. Environmental Geography: Savindra Singh, Prayag Pustak Bhawan, Allahabad (U.P.) 2001.
14. Fundamental Concepts in Environmental Studies: Dr. D. D. Mishra, S. Chand Publication, 2009.
15. **Environmental Chemistry:** B. K. Sharma & H. Kaur (Goel Publishing House, Meerut)
16. Industrial Chemistry: B. K. Sharma (Goel Publishing House, Meerut)
17. Environmental Chemistry: A.K. De, (Wiley Eastern Ltd), 1987.
18. A Text book of Environmental Chemistry: O.D. Tyagi, M. Mehra (Anand Publications Pvt, Ltd) 1994.
19. Environmental Chemistry: J. W. Moore and F. A. Moore (Academic Press, New Delhi), 1976
20. Environmental Chemistry: Samir K. Banerji (Prentice Hall, New Delhi)

21. Environmental Chemistry with Green Chemistry: Asim K. Das. Books and Allied (P) LTD. Kolkata
22. General Meteorology: H. R. Byers, Tata McGraw Hill Publications, New Delhi.
23. The Atmosphere: An Introduction to Meteorology: Fedrik K. Lutgen, E. J. Tarbuck
24. Meteorology: Dr. S.R. Gadekar, Agromate Publishers, Nagpur 2000
25. **Environmental Analysis**: M.M. Saxena, Agrobotanical Publisher, Bikaner 1994
26. Climatology: D.S. Lal, Shraddha Pustak Bhavan Allahabad, 2001
27. Atmosphere, Weather and Climate: K. Sidddhartha, Kisalaya Publication Pvt. Ltd 2000
28. Environmental Science: S.C. Santra, New Central Book Agency private Limited, 2006.
29. **Environmental Science Principles and Practices:** R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008
30. Water Pollution: V.P. Kudesia, Pragati Prakashan, Meerut. 2003.
31. Environmental Pollution Control Engineering: C.S. Rao, New Age International Priv.Ltd.Publishers.1997
32. Environmental Pollution Management and Control for Sustainable Development: R.K. Khitoliya. 1997
33. Environmental Chemistry: P. S. Sindhu. New Age International Priv. Ltd, 2002.
34. Noise Pollution and Control: S. P. Singal, Narosa Publishing House, 2000.
35. A Textbook of Environmental Pollution and Control: Dr. H. S. Bhatiya, Galgotiya Publications Ltd. 2000.
36. Environmental Chemistry: Ajaykumar Bhagi, G. R. Chatwal, Himalaya Publishing House. 2005.
37. Environmental Ecology: P. R. Yadav, Shubhrata R. Mishra, Discovery Publishing House, 2004.
38. Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers, 1985.
39. Plant Ecology and Soil Science: R.S. Shukla and P.S. Chandel, S. Chand Publication, 2001.
40. Maintaining Biodiversity in Forest Ecosystem: Malcolm L. Hunter Jr., Cambridge University Press, 1999
41. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: P.S. Verma, V.K. Agarwal. S. Chand Publication, 2005.
42. Animal Ecology and Environmental Biology: H.R. Singh, Vishal Publication.
43. Animal Physiology and Ecology: P.S. Varma, V.K. Agrawal, B.S. Tyagi, S. Chand, 2002.
44. Animal Ecology and Distribution of Animals: Rastogi, 1790.
45. Fundamentals of Ecology: Eugene P. Odum, (Natraj Publishers, Dehradun)
46. Principles of Ecology: P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi)
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)
53. Toxicology–Principles & Methods: M. A. Subramanian, MJP, Publishers, Chennai (2004).
54. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House, New Delhi.
55. A Textbook of Environmental Studies: G. R. Chatwal & Harish Sharma, Himalaya Publication House, New Delhi, (2004).
56. Environmental Biology: K.C. Agarwal, Agro-Botanica, Bikaner.
57. Fundamentals of Ecology: M.C. Dash, Tata McGraw Hill Publishing Company Ltd, New Delhi.
58. Environmental Ecology: Gurudeep Raj, P.R.Trivedi, Akashdeep Publishing House, New Delhi.

PSCENVP01

Practical I

Water Sampling Techniques and Analysis

General Laboratory Practices:

1. Laboratory concepts, rules, regulations and preparation of standard solutions.
2. Weighing capacity and sensitivity of balance care and use of balance.

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.
8. Determination of Dissolved Oxygen and Calculation of Percent Saturation.
9. Determination of COD of given wastewater sample by Open Reflux method.
10. Determination of BOD of given wastewater sample for 5 days at 20 ^{0}C.
11. Determination of oil and grease by Soxhlet apparatus or separation funnel.

Meteorological Analysis:

12. Measurement of Solar Constant.
13. Determination of wind velocity by three cups Robinson's anemometer.
14. Determination of relative humidity by Psychrometer.
15. Determination of current voltage characteristics of Solar Cell.
16. Study of Solar characteristics of Photovoltaic cell.

PSCENVP02

Practical II

Water and Soil Analysis

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.
6. Determination of Fluoride by SPANDS method.

7. Determination of Copper by Solvent Extraction method and Spectrophotometric method.
8. Determination of Nickel by Solvent Extraction method and Spectrophotometric method.
9. Determination Cobalt 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

12. Analysis of organic forming of soil for chemical parameter.

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

13. Analysis of synthetic fertilizer applied soil and comparison with organic forming soil for physicochemical parameter of soil.
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

1. Standard Methods for Examination of Water and Wastewater, 18th edition 1992, American Public Health Association (APHA), American Water Works Association (AWWA), New York.

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

3. A Textbook of Experiments and Calculations in Engineering Chemistry- S.S. Dara, S. Chand and Company Ltd. New Delhi 2003.

4. Handbook of Methods in Environmental Studies, Vol-I Water and Waste Water Analysis-S.K. Maiti, ABD Publishers, Jaipur India.

5. Handbook of Methods in Environmental Studies, Vol-II Air, Noise, Soil, Overburden, Solid Waste And Ecology- S.K. Maiti, ABD Publishers, Jaipur, India.

6. Environmental Water and Soil Analysis: P.R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi.
7. Encyclopaedia of Environmental Analysis Vol-I, II and III, G.R. Chatwal, Anmol Publications Pvt. Ltd., New Delhi.
8. Basic Analytical Chemistry: G. Sharma, Campus Books.
9. Vogel's Textbook of Quantitative Chemical Analysis: G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Low Priced Edition.
10. Chemistry for Environmental Engineering: Clair N. Sawyer, McGraw International Editions.

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

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.

PSCENVT06

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.
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 overused 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 concentrator, collectors-line focusing collector, parabolic trough reflector and mirror strip point focusing collector. 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-bulb turbine, 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.

PSCENVT07

Paper VII Environmental Disaster and Environmental Biotechnology

Unit I Environmental Disaster and Management

1. Geological Hazard: Introduction–types of environmental hazards. Floods, landslides, earthquake, volcano, snow avalanches and tsunami with a view to assess the magnitude of the problem, adjustment and preventive measures to natural hazards.
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.
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 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

research design; different research designs; basic principles of experimental designs.

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**.**
3. Interpretation and Report Writing: Interpretation–technique of interpretation; significance of report writing–steps in writing reports–types of reports–writing research reports–conclusions.

PSCENVT08

Paper VIII 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 and Thermal 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, nephalometer/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 spectrometery, molecular mass spectrometery, 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

1. General microbiology Volume I & II: C. B. Powar and H. F. Daginawala (Himalaya publishing House, Mumbai), 2002

2. Fundamental principles of Bacteriology (TMH Edition): A. J. Salle, (Tata McGraw-Hill Publishing Company Limited, New Delhi), 1974

3. Microbiology: P. D. Sharma (Rastogi publication Meerut)

4. Microbiology: Pelizer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi)

5. Hand book of Microbiology: Yu. S. Krivashein (Mir Publishers Mascow)

6. Microbiology for Environmental Engineering: M. C. Kinnery (Tata McGraw-Hill Publishing Company Limited, New Delhi)

7. Applied Microbiology: Vimta Kale & Kishore Bhusari (Himalaya Publishing House, Mumbai)

8. Soil Microbiology: Martin Alexander, Wiley Eastern Limited, 1981

9. Environmental Biotechnology: S. N. Jogdand, Himalaya Publishing House, Mumbai (2006).

10. A Textbook of Biotechnology: R. C. Dubey, S. Chand & Company, New Delhi (2002).

11. Instrumental Methods of Environmental Analysis: Karan Sareen, (Sarup ans Sons Publishers, New Delhi), 2001

12. Instrumental Methods of Chemical Analysis: B. K. Sharma, Goel Publishing House, Meerut (1996).

13. Standard Methods for the Examination of Water and Waste Water: (APHA, AWWA & WPCF), 1985

14. Instrumental Methods and Chemical Analysis: H. Kaur, Pragati Prakashan, Merrut (2009).

15. Instrumental Analysis: Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952

16. Instrumental Methods of Chemical Analysis: Chatwal and Anand (Himalaya Publishing House, New Delhi), 1994

17. Instrumental Analysis: Gurdeep Chatwal (Himalaya Publishing House, New Delhi), 2000

18. Instrumental Methods: V. B. Borade (Nirali Prakashan, Mumbai)

19. Environmental Chemistry: B. K. Sharma, Goel Publishing House, Meerut.

20. Environmental Chemistry : A. K. De (Wiley eastern limited, New Delhi)
21. Environment Problems and Solutions: D.K. Asthana and Meera Asthana, S. Chand & Co. Ltd. New Delhi.
22. **Noise Pollution and Control Strategy**: S.P. Singal, Narosa Publishing House, New Delhi.
23. Environmental Geography: Savindra singh, Prayag Pustak Bhawan, Allahabad (U.P.) 2001.
24. **Environmental Biology:** P. D. Sharma (Rastogi Publications), Meerut
25. **Principles of Ecology:** P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi)

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.
7. Effect of light/pollutant on Photosynthetic activity.
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 CO_2, 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
14. Determination of Organic matter of forest floor and waste land and its interpretation.
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 ^{0}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.
9. Determination of Settlable particles using dust fall jar apparatus.
10. Determination of Sulphation rate by Lead Peroxide method.
11. Construction and interpretation of wind roses and pollution roses.
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

1. Standard Methods for Examination of Water and Wastewater, 18th edition 1992, American Public Health Association (APHA), American Water Works Association (AWWA), New York.

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

3. A Textbook of Experiments and Calculations in Engineering Chemistry- S.S. Dara, S. Chand and Company Ltd. New Delhi 2003.

4. Handbook of Methods in Environmental Studies, Vol-I Water and Wastewater Analysis- S.K. Maiti, ABD Publishers, Jaipur India.

5. Handbook of Methods in Environmental Studies, Vol-II Air, Noise, Soil, Overburden, Solid Waste and Ecology- S.K. Maiti, ABD Publishers, Jaipur, India.
6. Environmental Water and Soil Analysis: P.R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi.
7. Encyclopaedia of Environmental Analysis Vol-I, II and III, G.R. Chatwal, Anmol Publications Pvt. Ltd., New Delhi.
8. Basic Analytical Chemistry: G. Sharma, Campus Books.
9. Vogel's Textbook of Quantitative Chemical Analysis: G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Low Priced Edition.
10. Chemistry for Environmental Engineering: Clair N. Sawyer, McGraw International Editions.