

**B.Sc. III Year
Semester VI
Environmental Science**

B.Sc. III year Environmental Science Semester V and VI

Gondwana University, Gadchiroli
Semester Pattern Syllabus for
B. Sc. III year, Semester VI
Environmental Science

General Instructions

- The examination of Semester V shall comprise of two theory papers of 3 hours duration of 50 marks each. Ten marks will be allotted for internal assessment for each theory paper.
- The examination of Semester VI shall comprise of two theory papers of 3 hours duration of 50 marks each. Ten marks will be allotted for internal assessment for each theory paper.
- Practical examination will be of 5 hours duration and separately for each semester having 30 marks each.
- Students should pass separately in Theory and Practical Examination.
- The syllabus is based on 6 theory periods and 6 practical periods per week.

Distribution of Practical Marks (Semester V and VI)

1	Two experiments	20 marks (10 marks each)
2	Certified practical record book	04 marks
3	Certified tour report/field diary	03 marks
4	Viva-voce	03 marks

Total 30 marks

GONDWANA UNIVERSITY, GADCHIROLI

Faculty of Science

B. Sc. III year Semester V and VI Environmental Science

Year	Semester	Paper	Paper title	Marks		Total marks	Total marks
				Theory	Internal		
B.Sc. III Year	V	I	Environmental Engineering	50	10	60	150
		II	Environment and Innovations	50	10	60	
		Practical	Practical	30	-	30	
	VI	I	Environmental Management	50	10	60	150
		II	Environmental Restoration	50	10	60	
		Practical	Practical	30	-	30	

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

Semester VI
Paper I
Environmental Management

Unit I: Solid Waste and Hazardous Waste Management

1. Solid Waste: Definition. Characteristic and perspectives. Sources of solid waste. Classification. Characteristic of solid waste: physical, chemical and biological. Solid waste generation. Factors affecting solid waste generation. Handling and separation of solid waste at source. Method of collection. Transfer station. Location of transfer station.

2. Methods of Treatment and Disposal: Composting. Sanitary land filling. Thermal process: incineration, pyrolysis and gasification. Waste reduction techniques: recycling- paper and paper board, plastics and glass.

3. Hazardous Waste and its management: Definition. Classification. Hazardous waste generation. Nuclear waste. Biomedical waste. Chemical waste. Identification of hazardous waste. Electronic waste (E-waste).

Hazardous waste treatment technology: On site disposal: physical, chemical and biological. Off-site disposal: Co-disposal and sanitary land filling. E-waste management. Biomedical waste management: autoclave, hydroclave, microwave, plasma treatment and disinfection by solar radiation.

Case study: Solid waste management of a city.

Unit II: Industrial Wastewater Treatment

1. Wastewater Treatment: Sources of wastewater. Objectives of treatment. Preliminary treatment: screening, comminuting, grit removal, flow measurement. Primary sedimentation.

2. Secondary Treatment: Activated sludge. Trickling filters. Stabilisation pond. Up-flow anaerobic sludge blanket reactor.

3. Tertiary Treatment: Wastewater disposal and reuse. Nutrient removal. Solid removal. Ozone treatment. Reverse osmosis. Ultraviolet filtration. Ion exchange. Wastewater disposal. Water reuse. Concept of common effluent treatment plant (CETP).

Case study: Pulp & paper industry wastewater treatment.

Unit III: Cleaner Technologies and EMS

1. Cleaner Technologies: Pollution reduction at source. Material modification and end of pipe technology. Eco labelling and Green building.

2. Environmental Economics: Tool for pollution prevention. Public disclosure and pollution control. Polluter pay principle. Industrial rating. Carbon trading: Role of

UNFCCC, Kyoto protocol. Joint implementation. Clean development mechanism (CDM). Carbon trading. Carbon credit. Ecological foot print.

3. Environmental Management System: Origin of EMS. ISO 9001-2008. Role of EMS, purpose, core element of EMS, ISO 14001:2004, ISO 14023:2004.

Case study: Implementation of cleaner technologies in an industry.

Unit IV: Environmental Impact Assessments

1. EIA: Origin of EIA. Objectives of EIA. EIA procedure. Project screening for EIA. Elements of the EIA Process. Design of an EIA. Stages in prior environmental clearance process: screening, scoping, public participation. Scope, studies for EIS. Preparation of an EIA: planning and public participation. Reviews of EIS.

2. Environmental Audit: Definition. Scope and objectives. Guidelines for EA. Procedure for carrying EA. Benefits of EA.

3. Environmental Management Plan: Construction phase. Project operation phase. Socio economic environment. Post project environmental monitoring. Development of green belt around industry.

Case study: Carry out an EIA study for a coal mine.

Books for Reference:

1. Natural Hazards-Local, National, Global: G. F. White, Oxford University Press.
2. Laboratory Manual for the Examination of Water, Waste water and soil: H. H. Rupa and H. Krist; V C H Publication
3. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.
4. Environmental Impact Assessment, L. W. Canter, McGraw Hill Publication,
5. Methods of Environmental Impact Assessment: P. Morris & R. Therivel ; UCL Press
6. Environmental Impact Assessment (2003): A. K. Srivastav; APH Publishing Corporation
7. Introduction to Environmental Impact Assessment: Glasson; Research Press
8. Sustainable development (Vol. I & II): N. L. Gupta and K. K. Gurjar (ed); Rawat Publications
9. Environmental management: G. N. Pandey; Vikash Publishing House
10. Environnemental management: H. M. Saxena; Rawat Publications
11. Environmental Law and Policy in India: S. Divan and A. Rosencranz; Oxford University Press
12. Environmental Management –Physio-ecological facets (Vol. I & II): Rai, Mohapatra & Goel (ed); Rawat Publications
13. Environmental Management in India (Vol. I & II): R. K. Saprui; Ashish Publishing House
14. Soli J. Arcivala: Waste Water Treatment for Pollution Control. TMH 1986.
15. Vijay Kulkarni & T. V. Ramchandra: Environnemental Management. Environmental Engineering Series; Publ. Commonwealth of Learning, Indian Institute of Science (IISC), Bangalore.
16. Environmental Management B. Khitolia, S Chand Publication, New Delhi
17. Solomon Raju: Ecotourism, Ecorestoration & Development, New central book agency, Bangalore.

18. Environment: Problems and Solutions, D.K. Asthana and Meera Asthana, S. Chand & Co., New Delhi
19. Environmental Chemistry, B.K. Sherma, Goel Publishing Housing, Meerut.
20. Textbook of Environmental Science and Technology, BSP Books Pvt. Ltd., Hyderabad
21. Environmental Impact Assessment, CRC Press, New York.
22. Environmental Impact Assessment Methodologies Anjaneyulu, Y. and Manickam W. BSP Books Pvt. Ltd., Hyderabad (2010)
23. Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons, New Delhi Carter, L. (1996)
24. Environmental Impact Assessment, McGraw Hill, New Delhi
25. Environmental Impact Assessment Methodologies. Anjaneyulu, Y. B S. Publications, New Delhi. (2002)
26. Productive and Sustainable Development, Rawat Publications, Jaipur.
27. Water Supply & Sanitary Engineering: G.S. Birdie
28. Managing industrial pollution (2003), S C Bhatia, Macmillan India Ltd. Mumbai
29. Environmental Chemistry and pollution control (1993), S.S. Dara, S. Chand and Company New Delhi.
30. Environmental Chemistry (1996), A.K. De, New Age International (P) Ltd., Mumbai
31. Environmental Sanitation, B. Kapoor, S. Chand and company, New Delhi
32. Elements of environmental engineering (2007). K N. Duggal. S. Chand and company, New Delhi

Semester VI

Paper II

Environmental Restoration

Unit I: Restoration Ecology

- 1. Basics of Restoration Ecology:** Definition. Necessity of eco-restoration. Principles. Concept. Types of restoration. Restoration ecology vs conservation biology. Holistic approach in restoration.
- 2. Approaches of Restoration:** Nature's healing potential. Major tools used in restoration. Physical, chemical and biological restoration. Role of ecological principles in restoration.
- 3. Strategies of Restoration:** Strategies (long vs short term), Govt. agencies and NGOs in conservation and restoration. Public participation in restoration. Indigenous knowledge of restoration.

Unit II: Eco-restoration Methods

- 1. Steps of Eco-restoration:** Five step wise eco-restoration. Restoration monitoring indicators. Biophysical analysis.
- 2. Components of Eco-restoration:** Components of eco-restoration. Seed collation and nursery process of re-vegetation plan. Selection of plant species. Method of sowing plants. New methods of plantation.
- 3. Eco-restoration by Plants:** Measures to restore environment: Phyto-extraction, phyto-stabilization, phyto-transformation, phyto-volatilisation, rhizo-filtration, rhizosphere bioremediation.

Unit III: Eco-restoration of Abiotic Environment

1. Restoration of Lands: Restoration of degraded lands. Restoration of soil fertility. Restoration of mine affected lands (coal mine, manganese mine, uranium mine, copper and gold mine). Restoration of damaged dunes. Restoration of wasteland. Restoration of non mineral extracted plains and hills.

2. Eco-restoration of Water and Air: Eco-restoration of groundwater, surface water (restoration of lakes, river, streams). Restoration of contaminated air: planting air pollutants absorbing plants, potential of carbon sequestration, design of space for plantation, planning and designing of green belt development in and around city. Role of local biodiversity management committee for restoration.

3. Eco-restoration of Hazard Hit Areas: Eco-restoration of super cyclonic hit areas. Restoration of snowstorm hit areas. Restoration of earthquake hit areas, volcanoes, landslides and floods affected areas.

Unit IV: Eco-restoration of Biotic Environment

1. Restoration of Natural Resources: Restoration of forest land, range land, restoration of wild animals, plants, role of forest research institutes. IIFM-Bhopal. Gene pool campaign.

2. Restoration of Biological Diversity: Acceleration of ecological succession. Reintroduction of biota. Restoration of wetland by mangroves. Restoration of mangroves (natural and artificial).

3. Socio-economic Issues of Restoration: Benefits of restoration to local inhabitants. Socioeconomic issues of lake beautification. Socioeconomic issues related with declaration of wildlife sanctuaries. Reasons of man-animal conflict. Wildlife tourism- benefits to local villagers. Issues regarding rehabilitation of Great Indian Bustard (GIB) in Maharashtra. Issues about conservation of wild buffaloes in Buxar, Chhattisgarh and rhinoceros in Assam. Environmental education and its role in conservation and restoration.

Books for Reference:

1. Managing Cover Crops Profitably, Handbook Series Book, Published by the Sustainable Agriculture Research and Education (SARE) program
2. Building Soils for Better Crops Sustainable Soil Management. Fred Magdoff and Harold van Es Handbook Series Book by the Sustainable Agriculture Research and Education (SARE) program. 2009.
3. Manage insect on your farm, Miguel A. Altieri and Clara I. Nicholls with Marlene A. Fritz, Published by the Sustainable Agriculture Network Beltsville, MD, USA.
4. A Whole-Farm Approach to Managing Pests, Sustainable Agriculture Research and Education (SARE) program.
5. Smart Water Use on Your Farm or Ranch, Sustainable Agriculture Research and Education (SARE) program.
6. Ecological Restoration: A Practical Approach, Steven I. Apfelbaum Applied Ecological Services, Inc. Brodhead, WI 53520
7. Eco-restoration of a high-sulphur coal mine overburden dumping site in northeast India: A case study J Dowarah, H P Deka Boruah, J Gogoi, N Pathak, N Saikia

- and A K Handique, Biotechnology Division, North-East Institute of Science & Technology, CSIR, Jorhat 785 006, Assam, India.
8. Dead Planet, Living Planet – Biodiversity and Ecosystem Restoration for Sustainable Development. A Rapid Response Assessment. United Nations Environment Programme, GRID-Arendal.
 9. Wetland Restoration: A Handbook For NZ Freshwater Systems, Campbell, D. and Jackson, R. New Zealand Hydrological and Limnological Societies, Christchurch, New Zealand. 2004.
 10. Cyclic floodplain rejuvenation, Jos van Alphen, Ministry of Transport, Public Works and Water management Directorate Eastern Netherlands December, 2001
 11. Wetland Restoration: A Handbook for NZ Freshwater Systems, Native Fauna, Corinne Watts, Monica Peters and Alastair Suren.
 12. Wetland Restoration: A Handbook for NZ Freshwater Systems, Wetland Protection, Monica Peters.
 13. Lessons learned from ecological, Vimukthi Weeratunga Biodiversity Coordinator, IUCN Sri Lanka Country Office restorations in Sri Lanka.
 14. Successful Ecological Restoration of Mangroves published by Mangrove Action Project - Yogyakarta, Indonesia. 2006.
 15. Principles and Guidelines for ecological restoration in Canada's Protected Natural Areas, Compiled by: National Parks directorate parks Canada agency gatineau, Quebec.

Semester VI Practical

Section A: Environmental Restoration

1. Study on nature's healing potential (rejuvenation after fire in forest), agricultural system.
 - i. Analysis of soil for NPK, organic carbon, inorganic carbon, trace metals etc.
2. Study on indigenous knowledge about eco-restoration: plantation and fire protection.
3. NGO's activities about restoration of lakes: Dewatering, weed removal, control of sewage flow, activities of fisherman communities.
4. Demonstration on nursery system (seed collection, preparation of pot), method of full grown tree plantation in urban area.
5. Pilot plants study on removal of pollutants by aquatic weeds (heavy metals) and other impurities.
6. Studies on restoration and re-stabilization of coal overburden dump by using different vegetation.
7. Studies on fertility of soil
 - i. Collection of soil sample before, during and after cropping.
 - ii. Analysis of physicochemical and biological parameters for fertility of soil
8. Studies on coal mine affected areas:
 - i. Collection of fresh over burden sample
 - ii. Collection of primary succession over burden sample for physicochemical analysis.
 - iii. Collection of secondary and climax vegetation on over burden for restoration studies.
9. Aerobiological studies of urban air environment

- i. Exposing nutrient plate to clean area, market area, slaughter house, traffic areas for microbes.
- ii. Dust fall studies by Dust fall jar
10. Wetland studies w.r.t.
 - i. Collection of soil sample
 - ii. Analysis of physicochemical parameters
 - iii. Soil dwelling fauna
11. Studies on restoration of non mineral exploited hills or plains for
 - i. Soil analysis
 - ii. Remedial measures
12. Analysis of waste land for fertility studies.
13. Groundwater restoration studies in urban and rural areas w.r.t. floatables (calcium, magnesium, suspended layer), dissolved calcium, TH, total acidity, fluoride.
14. Studies on restoration of lakes
 - i. Collection lake water samples for *in situ* control
 - ii. Planning and designing lake conservation measures
15. Comparative analysis of river water quality before and after recreation activities viz. bathing, washing cloths and washing domestic animals.
16. Analysis of streams water for assessment of self purification capacity
17. Studies and demonstration on carbon sequestration of plants/vegetation
18. Draw the design of green belt development by the road sides and industries
19. Survey of local biodiversity communities involved in protection of trees in your areas.
20. Demonstration on restoration of flood hit areas.
21. Demonstration of on gene campaign in India w.r.t.
 - i. Collection of indigenous seeds
 - ii. Discussion with people
 - iii. Preparation of herbarium (digital)
 - iv. Collection of fauna in digital format
22. To study forest management activities of IIFM, Bhopal.
23. Draw map and parameter for space design for vegetation in urban areas/rural areas.
24. Demonstration on snow storm in USA (2014).
25. Case studies on man animal conflict in your area.
26. Determination of pH, acidity, alkalinity, organic carbon, nitrogen from compost
27. Determination of suspended solids and total solids of raw sewage and sedimentation unit in waste water treatment plant.
28. Qualitative study of flora and fauna of aeration tank of waste water treatment plant.

Section B: Solid Waste Management and Wastewater Treatment

1. Sampling of solid waste by quartering method.
2. Determination of moisture content of the given solid waste sample by gravimetric method.
3. Determination of calorific value of the given solid waste sample by Bomb calorimeter method.
4. Determination of volatile and non-volatile matter of the given solid waste sample.
5. Estimation of Chemical Oxygen Demand of the given wastewater sample by open reflux method.

6. Estimation of Bio-chemical Oxygen Demand of the given wastewater sample by BOD 5 day method.
7. Estimation of phosphate of the given wastewater sample by stannous chloride method.
8. Estimation of sulphate of the given wastewater sample by precipitation method.
9. Estimation of chromium in the given wastewater sample.
10. Estimation of Bismuth in the given wastewater sample.
11. Estimation of Vanadium in the given wastewater sample.
12. Estimation of Nitrate in the given wastewater sample.
13. Estimation of total Kjeldhal nitrogen in a given wastewater sample.
14. Determination of different solids (total, suspended and dissolved) in a wastewater sample.
15. Estimation of phenol in wastewater sample.