Academic Council Meeting No. and Date: 8 / September 04, 2023
Agenda Number: 2 Resolution Number: 34, 35/2.17 & 2.38

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme: Master of Science

Specific Programme: Environmental Science

[M.Sc. (Semester I and II)]

Level 6.0

CHOICE BASED GRADING SYSTEM

Revised under NEP and Autonomy

From academic year 2023-24

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B. N. Bandodkar College of Science, (AUTONOMOUS)-Thane										
Master Program in Environmental Science										
Year (2 Yrs)	**LEVEL**	**SEMESTER**	**Major**			**Research Methodology**	**On Job Training / Field project**	**Research project**	**Cum Credits**	**Degrees**
			Mandatory		**Electives anyone**					
I	**6.0**	SEM-I	**3*4 + 2 = 14**		Credits 4	**Credits 4**	NA	NA	22	PG Diploma in Environmental Science (After 3 Yrs. degree UG)
			Course 1	Credits 4	Course 1= Credits 4					
			Course 2	Credits 4	**OR**					
			Course 3	Credits 4	Course 2 = Credits 4					
			Course 4	Credits 2	**OR**					
		SEM-II	Course 1	Credits 4	Course 1 = Credits 4	NA	**Credits 4**	NA	**22**	
			Course 2	Credits 4	**OR**					
			Course 3	Credits 4	Course 2 = Credits 4					
			Course 4	Credits 2	**OR**					
Cum Cr.for 1 Yr. PG Diploma			**28**		8	4	4		44	
II	**6.5**	SEM- III	Course 1	Credits 4	Course 1 Credits 4	NA	NA	**Credits 4**	22	Master Program in Environmental Science (After 3 Yrs. degree UG)
			Course 2	Credits 4	**OR**					
			Course 3	Credits 4	Course 2 Credits 4					
			Course 4	Credits 2	**OR**					
		SEM IV	Course 1	Credits 4	Course 1 Credits 4	NA	NA	**Credits 6**	**22**	
			Course 2	Credits 4	**OR**					
			Course 3	Credits 4	Course 2 Credits 4					
					OR					
Cum Cr. for integrated 1 Yr. PG Degree			**26**		**8**			**10**	**44**	
Cum Cr. for 2 Yr. PG Degree			**44**		**16**	**4**	**4**	**10**	**88**	

Preamble

The M.Sc. Environmental Science (EVS) Programme is designed to meet the current demands for professional and industrial consulting services. The improvement of administrative, management, and academic skills, and connection with the NET/SET curriculum.

The syllabus includes assignments for field trips, excursions, industrial visits, and specialized in plant training in industries in addition to academic courses. To inculcate analytical ability among the M.Sc. students syllabus included research methodology and various field projects. To develop competence, hands on training interest and communication skill, seminars, laboratory experiments, internship and stalwart's guest lecture will be arranged.

The Department of Environmental Science was established in the year 2011-12 with sufficient infrastructure facilities. The intake capacity is 20 for M.Sc. and 10 for the Ph.D.

Scope

Environmental science is a multidisciplinary science whose basic aspects have a direct relevance to every section of the society. Its main aspects are: Conservation of nature, natural resources and conservation of biological diversity. Being interdisciplinary sciences, it includes ecology, ethnology, biology, chemistry, geology, statistics, geographical information systems (GIS) with social relevance's. Significance of the courses is scope in the across the subjects in employment sectors including the private and government sectors.

The syllabi also include topics such as EIA, Pollution Control Technology, Environmental Policies & Regulations, Green Technology and Nanotechnology which has a bright career scope.

The electives subject can be select by the students as per their desire about their future professional areas. The independent research areas and acquisition of subject-specific skills within an interdisciplinary group of provides a wide range of opportunities in their careers interface with research aptitude, industry, government and society that would be brought by this program.

Dr. Sandhya Pawale
BOS Chairperson

Master of Science
Environmental Science Syllabus
(To be implemented from the academic year 2023-2024)

SEMESTER I and SEMESTER II

SYLLABUS FOR APPROVAL

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc. (Environmental Science)
2	Eligibility for Admission	Bachelor's Degree in Science (B.Sc.) or EvS and its equivalent
3	Passing Marks	40%
4	No. of Years / Semesters	Sem I and II
5	Level	P.G.
6	Pattern	Semester
7	Status	Revised under Autonomy and NEP 2020
8	To be implemented from Academic Year	2023-24
9	Name & Sign of BOS Chairperson /Coordinator Department of Environmental Science	Dr. Sandhya Pawale

Program Specific Outcome

The primary objectives of learning environmental science are for learners and learners to become aware of and knowledgeable about the environment develops attitudes, abilities, and skills, and take involved in real-world problem-solving environment-related issues.

The viewpoint should be extensive, interdisciplinary, and holistic in nature in addition to women, students, and teachers at schools, and tribal slums, the general public in rural, planners, and decision-makers, as well as universities. Upon the completion of this program, students and learners can understand fundamental concepts, principles and processes underlying in the field of Environmental Science, its interdisciplinary nature and create and disseminate knowledge to the students about environmental problems at local, regional and global scale.

Learners can apply environmental data analysis methodology in order to conduct research and demonstrate appropriate skill to seek innovative solutions to problems that emerge in various fields of Ecology and Environmental Science and interdisciplinary fields like Green Technology, Biotechnology etc. Employ skills in specific areas related to Environmental Science such as Environmental auditing, monitoring and assessment, industrial and chemical safety, toxicology, industrial pollution, green technology development, ecological, health, agriculture and ensure multilevel commitment to health and well-being of the society at large. They can also demonstrate with an understanding of a wide range of Environmental techniques.

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VPM's B. N. Bandodkar College of Science (Autonomous), Thane
M.Sc. Environmental Science
Structure of Programme
SEMESTER I

Course Code	Course Title	No. of Lectures	Credits
MAJOR PAPERS			
23BPEV1T1	Environment and Natural Resources	**60**	**4**
23BPEV1T2	Ecology and Ecosystem	**60**	**4**
23BPEV1T3	Environmental Pollution	**60**	**4**
23BPEV1P1	Practical based on Major Papers	**60 Hours**	**2**
ELECTIVE PAPERS			
23BPEV1T4	Biodiversity and Conservation	**30**	**2**
23BPEV1P2	Practical	**60 Hours**	**2**
OR			
23BPEV1T5	Pollution and Waste	**30**	**2**
23BPEV1P3	Practical	**60 Hours**	**2**
RESEARCH METHODOLOGY (RM)			
23BPRM1T1	Research Methodology	**60**	**4**
	Total Credits		**22**

SEMESTER II

Course Code	Course Title	No. of Lectures	Credits
MAJOR PAPERS			
23BPEV2T1	Environmental Monitoring and Assessment	**60**	**4**
23BPEV2T2	Pollution Control Technology	**60**	**4**
23BPEV2T3	Environmental Policies and Regulations	**60**	**4**
23BPEV2P1	Practical based on Major Papers	**60 Hours**	**2**
ELECTIVE PAPERS			
23BPEV2T4	Green technology	**30**	**2**
23BPEV2P2	Practical	**60 Hours**	**2**

OR			
23BPEV2T5	Environmental Nanotechnology	**30**	**2**
23BPEV2P3	Practical	**60 Hours**	**2**
ON-JOB TRAINING (OJT) / FIELD PROJECT (FP)			
23BPEV2P4	Internship/Training/Field Project	**120 Hours**	**4**
	Total Credits		**22**
	Total Semester I & Semester II Credits		**44**

Eligibility:

- B.Sc in ANY subject or its equivalent.
- B.Sc. in Environmental Science.

Mode of Conduct: Laboratory practical / Offline lecture / Hybrid lecture

SEMESTER I

MAJOR PAPERS

Course Code 23BPEV1T1	Course Title Environment and Natural Resources	Credits 4	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Understand the concept of environment, atmosphere, mass and energy. • Demonstrate comprehensive understanding of the environment, environmental processes, theories. • Ability to recognize and describe how about resource management and sustainability. • Learn the mitigation approaches, their choices and alternatives.			
UNIT I Environment	1.1 Definition of Environment, Evolution of environment. 1.2 Physico-chemical and Biological Characteristics of environment. 1.3 Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. 1.4 Geographical classification, Distribution and zones. 1.5 Minerals and their Classification. 1.6 Characteristics of Soil.		**15**
UNIT II Mass and energy	2.1 Definition of Mass and Energy. 2.2 Transfer of mass and energy across various interfaces. 2.3 First and second laws of thermodynamics, heat transfer processes. 2.4 Biogeochemical cycles, gaseous and sedimentary turnover rate and turnover item, General relationship between landscape and climate. Climates of India, global climate change. 2.5 Meteorological and Climatic Aspects, Elements of weather and Climate. 2.6 EL NINO and LA NINA Effect.		**15**
UNIT III Natural resources	3.1 Introduction to natural resources 3.2 Types of natural resources: 3.2.1 Forest resources: Introduction to forest resources, Types of forest 3.2.2 Water resources: Surface water resources, River network of India, Ground water resources, Groundwater status of India. Use and utilization of surfaces and ground water. 3.2.3 Mineral resources: Mineral resources in India, Metallic and Non-metallic resources, Major Mineral Producing States in India according to the Mineral Belts. 3.2.4 Food resources: Food sources, Food crops, Live Stock, Aqua culture 3.2.5 Land resources: Land resources in India, Utilization of land resources in India, Land Cover and Land Use. 3.3 Role of an individual in conservation of natural resources.		**15**
UNIT IV Energy resources	4.1 Concept and demand of energy, Growing energy needs 4.2 Renewable and non- renewable sources 4.3 Use of alternate energy sources, Wind energy, Solar energy, Tidal energy, Nuclear energy, Water as source of energy 4.4 Biofuels production, use and sustainability, use and over exploitation of energy sources and associated problems. 4.5 Waste to Energy, Clean Energy, Sustainable Energy, Equitable use resources for sustainable lifestyles.		**15**

Texts/References:

1) Renewable Energy – Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd. Alternative Energy: S. Vandana; APH Publishing Corporation

2) Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation

3) S. Glass stone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany, 1967

4) M. Eisendbud, Environmental radioactivity, Academic Press

5) E.D.Enger, B.E. Smith, Environmental Sciences- A study of Inter relationships, WCB Publication

6) Bio-Energy Resources: Chaturvedi; Concept Pub.

7) National Energy – policy, crisis and growth: V S. Mahajan; Ashis Publishing House

8) Geography and Energy – Commercial energy systems and national policies: J. D. Chapman

Course Code 23BPEV1T2	Course Title Ecology and Ecosystem	Credits 4	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Demonstrate sound understanding on scientific inquiry in the field of modern ecology. • Understand structure and functions of ecosystem. • Examine the main limitations/ stress on patterns of productivity, energy flow through natural food webs, and ecosystems dynamics. • Ability to set up basic and advanced ecological sampling techniques in different ecosystems			
UNIT I Ecology	1.1 Definition, principle and scope of ecology. 1.2 Aquatic and terrestrial ecology, freshwater ecology, marine ecology, estuarine ecology Community concept, types of community, competition and Coexistence. 1.3 Types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, predator and prey relationship.		**15**
UNIT II Concept of Biosphere and ecosystem	2.1 Definition of environment, Abiotic and Biotic environment, limiting factors, adaptation, Habitat and niche. 2.2 Biomes, Population parameters, structure, Growth Regulation. 2.3 Types of ecosystems, eco system of India, Characteristics of eco system, structure of ecosystem and function of an ecosystem. 2.4 Marine Environment: Indian marine territory, Biota in different types of zones, its diversity-plankton, nekton, benthos, their adaptations and productivity, Exclusive Economic Zones (EEZ), distribution of mangrove areas in India, ecological importance of mangrove vegetation. 2.5 Dynamic biogeography: routes of migration of plants and animals, their impact on local ecosystems, trade routes, shipping, accidental import, weeds, ballast water.		**15**
UNIT III Organization of Ecological systems	3.1 Components of Ecosystem: Biotic and abiotic components 3.2 Producers, consumers and decomposer. 3.3 Food chains, food web, and ecological pyramids, population Dynamics, Carrying capacity, construction of ecological pyramids. 3.4 Bioaccumulation and biomagnifications. 3.5 Ecosystem Services, Ecological Footprint, Bio capacity, Quantification of Ecological Footprint.		**15**
UNIT IV Energy and Ecological succession	4.1 Models of Flow and energy fixation, mass and energy transfer in successive trophic level. 4.2 Biogeochemical cycles: Sources, Phases of biogeochemical cycles, biotic phase (organic phase) and the abiotic phase, fluxes, sedimentation. 4.3 Anthropological activities on biogeochemical cycles. 4.4 Theories of ecological climax, Ecological succession, Types of ecological succession: primary succession, secondary succession, examples of ecological succession. 4.5 Impacts of development on ecosystem.		**15**

Texts/References:

1) E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.

2) K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC, Boston.

3) M.C. Dash (1994) Fundamentals of Ecology, Tata McGraw Hill, New Delhi.

4) M.C. Molles Jr. (1999) Ecology- Concepts and Application, McGraw Hill, New Delhi.

5) V. Ingegnoli (2002) Landscape Ecology: a widening foundation, Springer, Bonn.

6) E.J. Kormondi (1999) Concepts of Ecology, Prentice Hall of India, New Delhi.

7) Chapman, J.L. and Reiss M.J. (2005) Ecology Principles and Applications, Cambridge University Press, London.

8) E.P. Odum and G. W. Barrett (2005) Fundamentals of Ecology, Thomson Asia Pvt. Ltd., Singapore.

9) S.V.S. Rana (2005) Essentials of Ecology and Environmental Sciences, Prentice Hall of India, New Delhi.

10) Environment And Ecology-EAS105/EAS 205-R. Rajagopalan

11) Environmental Studies from Crisis to Cure-2nd Edition-R. Rajagopalan

12) Fundamentals of Environmental Science and Ecology (Zigma Publication)

Course Code 23BPEV1T3	Course Title Environmental Pollution	Credits 4	No. of lectures

Course Outcomes:

After completing this course learner will be able to:

- Apply knowledge of Environmental Pollution to understand issues relating to the problems of pollution, its impacts on the biosphere.
- Impart the knowledge and understanding of causes and effects of air pollution and their controlling mechanisms.
- Explain the different types of water pollution and demonstrate the impact of water pollution on environment.
- Find practical ways for pollution management.

UNIT I Air pollution	1.1 Pollution: Definition and sources of pollution; 1.2 Air pollution: Types and sources of air pollutants, Properties of air pollutants Impact of air pollution on global, regional and local aspects. 1.3 Reaction of pollutants in air forming smog, Ozone Formation and Depletion, PAN, Acid rain, greenhouse gases and greenhouse effect. 1.4 Atmospheric diffusion and stack performance; Transport of pollutants 1.5 Air Quality Index. 1.6 Effects of air pollutants on flora and fauna, human health; Sinks of atmospheric gases. 1.7 Air (Prevention and Control of Pollution) Act 1981	**15**
UNIT II Water Pollution	2.1 Sources of water and their contamination: domestic water pollution, industrial water pollution, agricultural water pollution, thermal water pollution, oil water pollution, toxic water pollutants and their effects 2.2 Types of pollutants, various industrial effluents such as pulp and paper mills, oil exploration and refinery, petrochemicals, iron and steel industries, Domestic wastes, organic debris, agricultural wastes, pesticides. 2.3 Eutrophication – causes, effects and control measures 2.4.1 Water (Prevention and Control of Pollution) Act, 1974 2.4.2 Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003.	**15**
UNIT III Soil Pollution	3.1 Sources, types and causes of soil pollution; 3.2 Effects of fungicides and weedicides on soil components, residual toxicity. 3.3 Different kinds of synthetic fertilizer (N, P, K), and their interactions with different components of soil, their toxicity. 3.4 Industrial effluents and their interactions with soil components, Contamination by radio nuclides.	**15**

UNIT IV Thermal and Oil pollution	4.1 Definition and sources of thermal pollution 4.2 Chemical and biological effects of thermal pollution, 4.3 Effect on marine life, bacteria and water quality and other aquatic biota; 4.4 Thermal pollution from power plants and their control. 4.5 Sources of oil pollution, Oil pollution and marine ecology, factors effecting fate of oil after spillage 4.6 Water quality monitoring: movement, spreading, evaporation, emulsification, dispersion, remote sensing	**15**

Texts/References:

1) J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.

2) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.

3) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications,2nd Edition, McGraw-Hill, 2000.

4) Air Pollution – Stern

5) Environmental Pollution Control Engineering: C. S. Rao

6) Environmental Chemistry: B.K. Sharma, and H. Kaur

7) Air pollution – threat and response: D. A. Lynn

8) Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication

Course Code 23BPEV1P1	Course Title Practical	Credits 2

1. Determination of Shannon-Wiener diversity indices in plant communities.

2. Determination of Chlorophyll content from plant species.

3. Determination of primary productivity by light and dark bottle method.

4. To analyze the carbon sequestration of plant species.

5. Determination of total organic matter in soil.

6. Determination of pH value of different types of soil using indicator.

7. Determination of water holding capacity of soil.

8. To study the soil profiles for their height, color, texture and electrical conductivity.

9. Measurement of photo density flux by Luxmeter.

10. To demonstrate total nitrogen value of the soil by Kjeldahl's method

11. Determination of Dissolved Oxygen of water sample by Winkler's method.

12. Determination of Chemical Oxygen Demand value for industrial waste effluent.

13. Determination of CO_2 in the atmosphere by volumetric method.

14. Estimation of Free Lime Analysis

15. Comparative study of Air Quality Index.

Texts/References:

1. Standard methods for examination of water and waste water, American Public Health Association.

2. A comprehensive laboratory manual for Environmental Sciences and Engineering by P.R. Sreemahadevan Pillai. New Age International Publishers.

3. Chemical and biological methods for water pollution studies By R.K. Trivedi

4. Handbook of water and waste water analysis By S.K. Maiti.

5. Soil and air analysis by S.K. Maiti.

ELECTIVE PAPERS

Course Code **23BPEV1T4**	**Course Title** **Biodiversity and Conservation**	**Credits** **2**	**No. of lectures**
Course Outcomes: After completing this course learner will be able to: • Demonstrate sound understanding on importance of biodiversity. • Explain sustainable utilization and conservation of biodiversity. • Summarize the role of important biodiversity laws, convention and organizations.			
UNIT I Biodiversity Status	1.1 Introduction to Biodiversity: Types of Biodiversity: α, β, γ diversity, Economic Importance, ecotone, Flagship species, key stone species and umbrella species. 1.2 Biodiversity status: National status and Global status, Biodiversity hotspot; 1.3 IUCN Category, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species, threatened species 1.4 Common flora and fauna in India-Aquatic: phytoplankton, Zooplankton and macrophytes. 1.5 Terrestrial ecosystem: Forests; Endangered and threatened species. 1.6 wildlife distribution in India, problem in wildlife protection. 1.7 Biodiversity Act 2002		**15**
UNIT II Biodiversity Convention and Conservation	2.1 Importance of Biodiversity conservation, Different approaches for Biodiversity conservation. 2.2 IPRs, national and international programs for biodiversity conservation 2.3 Role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act 1972. Joint Forest Management, People's Biodiversity Register, Speciation in PAN India, NAGOA protocol. CBD, AICHI. 2.4 In-situ conservation: sanctuaries, biospheres reserves, national parks, nature re- serves, preservation plots. 2.5 Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank. 2.6 Current status and Case Studies of Biodiversity Conservation Projects (flora and fauna). 2.7 Indian Wildlife (Protection) Act, 1972		**15**
Practical **23BPEV1P2**	1. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters. 2. Identification and description of economically important plant species. 3. To plot biosphere reserve on a map of India. 4. Prepare a document of endemic and exotic species of plants/animals for a selected PAN. 5. Indicate distribution range of a plant and animal species identified as endangered on an Indian map. 6. Prepare a map of. Maharashtra showing Protected Area Network (PAN) in it. 7. To study qualitative and quantitative characters of a plant community by quadrate method. 8. To study a plant community by using line transect method,		**2 Credit**

	using line, belt and profile transects. 9. Study of phytoplankton and zooplankton from water sample. 10. Visit to: seed bank, national park. 11. Preparation of herbarium of any 5 plants 12. To set up of a butterfly garden	

Texts/References:

1) Sustaining Life: How Human Health Depends on Biodiversity Eric Chivian Aaron Bernstein (2008)

2) Shahid Naeem, Daniel E. Bunker, Andy Hector and Michel Loreau (2009) Biodiversity, ecosystem functioning and human well-being: An ecological and economic perspective

3) S.K. Agarwal et al (1996) Biodiversity and Environment, APH, Dehra Dun.

4) S.S. Negi (1993) Biodiversity and its Conservation in India, Indus Publications, New Delhi.

5) W.W. Collins and C.O. Qualset (1998) Biodiversity in Agro-ecosystem, CRC, Boston.

6) V.K. Krishnamurthy (2003) Text Book of Biodiversity, Science Publisher, Chennai.

7) P.S. Ramakrishnan (2000) Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge, Oxford and IBH, New Delhi

8) Global Biodiversity strategy: WRI, IUCN & UNEP

9) Ecotourism and Sustainable Development: Singh; Abhijeet Pub

Course Code 23BPEV1T5	Course Title Pollution and Waste	Credits 2	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Apply knowledge of radiation, noise, solid waste pollution to understand issues relating to the problems of pollution, its impacts on the biosphere • Find practical ways for pollution management.			
UNIT I Radiation and Noise pollution	1.1 Sources of Nuclear Energy, Units of radioactivity and radiation dose; 1.2 Radioactive decay; Biological impact and health hazards associated with radiation. 1.3 Half Life Hazards, Protection against ionizing isotopes and their applications in waste water and air pollution analysis and treatment; 1.4 Radioactive waste disposal. 1.5 Basic properties of sound waves – plane and spherical waves, sound pressure, loudness and intensity levels, decibel; 1.6 Sources of Noise Pollution 1.7 Effects of noise pollution on human health 1.8 Measurement and analysis of sound, Measures to control noise pollution. 1.9 Noise Pollution (Regulation and Control) Rules, 2000		**15**
UNIT II Solid Waste Pollution	2.1 Solid waste pollution: sources, nature, classification and environmental effects. Municipal Solid Waste 2.2 Classification of E Waste, Sources and types and constituents of E-wastes and its environmental consequences 2.3 E-waste Management and Handling Rules 2011 2.4 Plastic waste: Types of Plastics and its impacts on environment 2.5 Microplastics; Alternatives to plastic use: bioplastics 2.6 Pollution as an opportunity: Ecobricks. 2.7 Biomedical waste: sources, types and segregation of waste. 2.8 Plastics Manufacture, Sale and Usage Rules, 2011		**15**
Practical **23BPEV1P3**	1.Determination of Total Dissolved Solids from the lake water. 2.Determination of Total Hardness of well water. 3. Determination of physical parameters of given type effluent/water sample a. Well water b. Industrial c. River water d. Sea water e. lake water. 4. Estimation of Silicates 5. Measurement and classification of noise pollution. 6.Determination of quality of stagnant water using Nygaard index (eutrophication technique) 7. Determination of water transparency by Secchi discs 8. Determination of wind velocity by anemometer.		**2 Credit**

Texts/References:

1) J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.

2) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.

3) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications,2nd Edition, McGraw-Hill, 2000.

4) Air Pollution – Stern

5) Environmental Pollution Control Engineering: C. S. Rao

6) Environmental Chemistry: B.K. Sharma, and H. Kaur

7) Air pollution – threat and response: D. A. Lynn

8) Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication

SEMESTER II

MAJOR PAPERS

Course Code 23BPEV2T1	Course Title Environmental Monitoring and Assessment	Credits 4	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Building the foundation for understanding Remote Sensing and Geographic Information System (RS GIS) as a powerful tool for geospatial analysis • Learn about data and sources (RS based and other sources, field data) and GIS software. • Obtain basic capability in skills and functional knowledge to carry out GIS (RS-GIS) based project			
UNIT I Environmental Monitoring	1.1 Concept of environmental quality. 1.2 Deterioration of environmental quality with reference to anthropogenic impact; 1.3 Methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short- and long-term monitoring, Environmental Samplings, Instrumentation and Sampling Equipment. 1.4 Advantages of Environmental Monitoring		**15**
UNIT II Environmental Impact Assessment (EIA)	2.1 Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies 2.2 Environmental Impact Assessment Techniques-Ad-hoc method, checklist method. 2.3 Process of EIA 2.4 Form I and I A 2.5 Merits and Demerits of EIA studies. 2.6 EIA Notification 2006		**15**
UNIT III Geographical Information System (GIS)	3.1 GIS: Basic principles, Techniques. 3.2 Types of Geographical Data; Data Structure; Vector and Raster data: their Advantages and Disadvantages; Input, verification, storage and output of geographical data; 3.3 Importance of Geographical Information System in environmental studies. 3.4 Global Positioning System (GPS): basic principles 3.5 Applications to environmental studies -Point source pollution, hazard monitoring and assessment. 3.6 GIS based Model: Invest Model, Traffic Model of Google Maps		**15**
UNIT IV Remote sensing and its applications in Environmental Monitoring	4.1 Principles and Basic concepts of Remote sensing; EMR. 4.2 Aerial Photography and image recognition; Sensors & platforms; IRS satellites Types & their sensors 4.3 Software for Remote Sensing: Q-GIS, R GIS, SAGA, DIVA GIS, US GIS, BHUVAN 4.4 Application of remote sensing in environmental studies: land use mapping, forest survey, habitat analysis, water management, drought monitoring and flood studies, wetland survey; rainfall estimation, pollution studies, soil conservation, watershed management and vegetation mapping.		**15**

Texts/References:

1.D. P. Lawrence (2003) Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons, New Delhi.

2. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.

3. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication.

4. P. Morris and R. Therivel (2001), Methods of Environmental Impact Assessment, Spoon Press.

5. J. Weston (1997) Planning and EIA in Practice, Longman.

6. Jos Arts and Angus Morrison-Saunders (2004) Assessing Impact - Handbook of EIA and SEA follow up, Earthscan, London.

7. Website of MoEF, GOI, New Delhi 8. Srivastava, D. C. (2005) Readings in Environmental Ethics: Multidisciplinary perspectives, Rawat Publications, Jaipur.

Course Code 23BPEV2T2	Course Title Pollution Control Technology	Credits 4	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Identify and quantify the magnitude and intensity of Environmental pollution problems. • Undertake environmental sampling and analysis with respect to air, water and soil pollution. • Suggest the environmental control /management plan for environmental pollution problems			
UNIT I Water Pollution control technologies	1.1 Sewage and waste water treatments systems: 1.2 Stages in wastewater treatment 1.2.1 Primary: Screening, Grit removal, sedimentation 1.2.2 Secondary: Biological treatments - aerobic versus anaerobic treatments; Measurement of treatment efficiencies; Activated sludge. 1.2.3 Tertiary treatments; 1.3 Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment. 1.4 Environmental pollution control- Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments; 1.5 Reactors types and design;		**15**
UNIT II Air pollution control technologies and devices	2.1 Air pollution standard Bharat 6 and 7; Polluter pays principle 2.2 Methods to control air pollution in the environment from industry: Limestone injection and fluidized bed combustion, Desulfurization, Centrifugal collectors- cyclone collector and dynamic precipitators. 2.3 Methods to control air pollution in the environment from vehicles: Catalytic converter and control of vehicular emission, Gravity settling chamber, Electrostatic precipitators; Fabric filters 2.4 Case study: CO_2 diamond startups-Aether Diamonds, Breathe Fresh-Vayu Natural Bag, Graviky Labs-Air-Ink; Kalink.		**15**
UNIT III Solid Waste management	3.1 Types of Solid waste disposal methods – Types of Landfills: Open and secure; Incineration: Energy from waste: pyrolysis, gasification, incineration 3.2 Recycling and reuse. 3.3 Organic pollutants and Hazardous waste disposal and management. 3.4 Formal and Informal sectors for e waste 3.5 Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation, 3.6 Municipal Solid Waste (Management and Handling Rules) 2000		**15**

UNIT IV Biotechnological methods to control pollution	4.1 Concept of Bioremediation, Biotransformation and Biodegradation 4.2 Methods in determining biodegradability; Contaminant availability for biodegradation.; Factors affecting process of biodegradation 4.3 In situ and Ex situ bioremediation; Bioremediation of VOCs. 4.4 Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation; 4.5 Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment. 4.6 Phytorid technology	**15**

Texts/References:

1) M.H.Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation.

2) M.H.Fulekar (2010) Bioremediation technology recent advances, springer.

3) N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York.

4) Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications,2nd edition, McGraw-Hill, 2000.

5) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.

6) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications,2nd Edition, McGraw-Hill, 2000.

7) Mizrahi & Wezel, Advances in Biotechnological Process

8) Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.

9) Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.

Course Code 23BPEV2T3	Course Title Environmental Policies and Regulations	Credits 4	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Demonstrate understanding Environmental Laws and policies in India. • Critically appreciate national and international laws and policies connected with India. • Apply critical mind in policy and approach aimed at resolving environmental issue, which, often, are with social aspects.			
UNIT I Evolution of International Environmental Policy	1.1 Fundamental principles of environmental protection - sustainable development Brundtland report 1987. 1.2 Role of International Environmental Agencies -UNEP, GEF, UNFCC and IPCC 1.3 Role of National Environmental Agencies: MoEFCC, MPCB, CPCB 1.4 Intergenerational and intra-generational Equity, precautionary principle, Public Trust Doctrine. 1.5 Constitutional Perspective: Fundamental right to wholesome environment. Directive principles of state policy. Fundamental duty. 1.6 National Environmental Policy. 1.7 Environmental Regulatory Framework in India.		**15**
UNIT II Environmental Movement in India	2.1 Movements related to Environment Sacred groves: Bishnoi movement, Silent Valley, Chipko movement, Tehri Dam Movement, Appiko Movement, Jungle Bachao Andolan, Narmada Bachao Andolan, Sardar Sarovar Dam, Almatti dam. 2.2 Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case, 2.3 Case Studies: Save Aarey Forest, Pollution in Bichhri, Mining in Sariska,Yamuna river water pollution, India Paryavaran Bhavan Case, Swachh Bharat Abhiyan.		**15**
UNIT III International Environmental Treaties and Conventions	3.1 Stockholm Conference on Human Environment,1972 3.2 Ramsar Convention on Wetlands, 1971 3.3 Basel Convention (1989,1992), 3.4 Earth Summit at Rio de Janeiro,1992 3.5 Kyoto Protocol, 1997 3.6 Convention on Desertification 1996 3.7 Convention on Biodiversity & Cartagena Protocol on Bio safety 3.8 Paris Agreement 3.9 CERP		**15**

UNIT IV Objectives and Provisions of Acts and Rules	4.1 Indian Forest Act 1927 4.2 Forest Conservation Act 1980 4.3 Forest Rights Act 4.4 Environment (Protection) Act, 1986 4.5 Bio-Medical Waste (Management & Handling) Rules,1998 4.6 The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,2008 4.7 Wetland Rules 2009 4.8 National Green Tribunal Act 2010 4.9 Coastal Regulation Zones (CRZ) Rules 2011.	**15**

Texts/References:

1.Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2005

2. Leelakrishnan. P, 2008, Environmental Law Case Book , Lexis Nexis, Butterworths

3. Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.

4.Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow

5.Singh Gurdip, 2004, Environmental Law in India, Mcmillan & Co.

6.Shantakumar S,2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa& Company, Nagpur

7.Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press (India)

8.Environmental Policy by Keith Neil

9.Environmental Impact Assessment and Management by Khitoliya R.K

Course Code 23BPEV2P1	Course Title Practical	Credits 2

1. Interpretation of Aerial photographs and preparing weather report based on it.
2. Determination of relative humidity from the atmosphere.
3. Determination of Salinity of water by Volhard's method.
4. Determination of moisture content, alkalinity/acidity of soil sample.
5. To prepare the station-based wind rose for an area.
6. Determination of Residual Chlorine from drinking water using colorimetric method.
7. Study the effect of pH on microbial growth.
8. Study the effect of heavy metals on the growth of bacteria.
9. Determination of K_2O value of soil by flame photometer.
10. Determination of P_2O_5 from soil by Olson's colorimetric method.
11. Determination of SO_2 by spectrophotometry/ NO_2 by Colorimetric method using high volume sampler.
12. Determination of particulate matter from the industrial area by High Volume Sampler/Settling method.
13. Report on Eco-tourism.
14. Reports on various study tours/academic visits.
15. To attend/present research papers in National/International Conferences.

Note: Students should undertake field work and survey. The students should visit different places to collect data to make survey and analyze. At least four places may be visited. The Places of visit could be: Lakes, rivers, estuary and marine, nature parks, water/ sewage/ Industrial effluent treatment plant, Solid waste dump, meteorological centre, mangrove vegetation, industries – food, pharmaceutical, petrochemical, fertilizer, paper, sugar, distillery etc. The students should also be encouraged to participate in the public lectures/ seminars/ workshops etc. on environment related issues. Reports on each of visit/ activity undertaken must be included in the journal.

Texts/References:

1. Standard methods for examination of water and waste water, American Public Health Association.
2. A comprehensive laboratory manual for Environmental Sciences and Engineering
By P.R. Sreemahadevan Pillai. New Age International Publishers.
3. Chemical and biological methods for water pollution studies By R.K. Trivedi
4. Handbook of water and waste water analysis By S.K. Maiti.
5. Soil and air analysis by S.K. Maiti.

ELECTIVE PAPERS

Course Code 23BPEV2T4	Course Title Green technology	Credits 2	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Realize the importance of green technologies in sustainable growth of Industry and society. • Adopt alternative methods and solvents for green synthesis. • Develop cleaner production and treatment mechanism for pollution prevention.			
UNIT I Introduction to Green Technology and Green Chemistry	1.1 Overview, Principle, concepts and Tools of Green technology. 1.2 Overview of green chemistry, Chemistry of the atmosphere, goals of green chemistry, twelve principles of green chemistry. 1.3 Concepts of atom economy and carbon trading, waste minimization and climate change, concept of environmentally balanced industrial complexing and industrial ecology, 1.4 Catalytic methods in green synthesis, safer chemicals - different basic approaches; selection of auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements-use of microwaves, ultrasonic energy; 1.5 Selection of starting materials; use of blocking/protecting groups, catalytic reagents; designing of biodegradable products.		**15**
UNIT II Applications of Green Technology and Green Chemistry	2.1 Biocatalysis, green chemistry in industries 2.2 Energy Technology: fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, 2.3 Waste Control Technology: Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. 2.4 Green Technology in circularity: Industrial ecology, concept of green building 2.5 Agricultural related practices and food processing, Production of biodegradable materials, Pollution free engineering processes.		**15**
Practical **23BPEV2P2**	1. To study the principle and application of Atomic Absorption Spectrophotometry for analysis of metal ions from samples. 2. To study the principle and application of Nephelometry and Turbidimetry: General discussion, Instruments for nephelometry and turbidimetry 3. Extraction and separation of organic compounds from soil and biological materials. • Ammonium sulphate method (Nichols method), • TCA method, • Acid digestion method, • Steam distillation for volatiles 4. To study different separation Techniques: Principle and process of solvent extraction; Chromatography – principle and application of thin layer and ion exchange chromatography, Gas Chromatography and High-Performance Liquid Chromatography. 5. Biofuel production methods and characterization for biodiesel and bioethanol 6. Preparation of eco-friendly products: color, idol, bag, 7. Case Study: Green Buildings in India, Green Products		**2 Credit**

Texts/References:

1) Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007

2) Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York, 2001

3) Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford Univ. Press: Oxford, 1998.

4) Lynn E. Foster: Nanotechnology: Science, Innovation, and Opportunity, December 21, 2005, Prentice Hall

5) Caye Drapcho, Nhuan Phú Nghiêm, Terry Walker (2008). Biofuels Engineering Process Technology. [McGraw-Hill].

6) Akhlesh Lakhtakia (ed) (2004). The Handbook of Nanotechnology. Nanometer Structures: Theory, Modeling, and Simulation. SPIE Press, Bellingham, WA, USA

7) Green Chemistry: A Textbook by V.K.Ahluwalia

8) Handbook of Green Chemistry by Paul Anastas

Course Code 23BPEV2T5	Course Title Environmental Nanotechnology	Credits 2	No. of lectures
Course Outcomes: After completing this course learner will be able to: • Discover knowledge of Nanoscience and related fields. • Acquire an understanding the Nanoscience and Applications • Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment			
UNIT I Nanotechnology	1.1 Introduction to Nanotechnology and green nanotechnology, Nanoparticles; Nanomaterials-Remediation, Nano Membranes, Nano Fibers, Nano Clays Adsorbents, Zeolites, Nano Catalysts, Carbon Nano tubes, Fullerene 1.2 Green nanoparticle production and characterization; Biocompatibility; 1.3 **Nanotechnology Development in India** 1.3.1 Global Trends in Nanotechnology 1.3.2 Importance of Nanotechnology for Developing Countries 1.3.3 Evolution of Nanotechnology in India **1.4 Nanotechnology Research, Development and Innovation in India: Major Actors:** 1.4.1 Department of Science and Technology (DST) 1.4.2 Department of Biotechnology (DBT) 1.4.3Department of Electronics and Information Technology (DeITy) 1.4.4 Department of Industrial Policy and Promotion (DIPP) 1.4.5 Department of Industrial and Scientific Research		**15**
UNIT II Application of Environmental Nanotechnology	2.1 Nanomedical applications of green nanotechnologies; 2.2 Nanotechnology and its Applications in Agriculture and Food Industry, Nanotechnology: Materials and Manufacture, 2.3 Nanotechnology for Renewable Energy, 2.4 Nanotechnology in the Environment 2.5 Nanotechnology- Risks for Health and Environment, Benefits for the Environment. 2.6 Environmental Nano Remediation Technology- Thermal, Physico-Chemical, and Biological Methods, Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens, Nanotechnology for Water Purification.		**15**
Practical **23BPEV2P3**	1. To Study the chemical reactions involved in green nanotechnology: Nanoparticle production 2. Characterization of nanoparticles using: • SEM-Working principle, components, and application • TEM- Working principle, components, and application • Spectroscopy- Working principle, components, and application 3. Synthesis and characterization of Ag nanoparticles using spectrophotometer. 4. Synthesis and characterization of Zn nanoparticles using spectrophotometer. 5. Antimicrobial activity of metals/oxides nanoparticles 6. Study of white rot fungi in nanotechnology with examples 7. Visit to nanotechnology laboratory		**2 Credit**

Texts/References:

1) M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishing house Pvt.Ltd.
2) Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007
3) Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York, 2001
4) Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford Univ. Press: Oxford, 1998.
5) Lynn E. Foster: Nanotechnology: Science, Innovation, and Opportunity, December 21, 2005, Prentice Hall
6) Fei Wang & Akhlesh Lakhtakia (eds) (2006). Selected Papers on Nanotechnology—Theory & Modeling (Milestone Volume 182). SPIE Press
7) Caye Drapcho, Nhuan Phú Nghiêm, Terry Walker (2008). Biofuels Engineering Process Technology. [McGraw-Hill].
8) Akhlesh Lakhtakia (ed) (2004). The Handbook of Nanotechnology. Nanometer Structures: Theory, Modeling, and Simulation. SPIE Press, Bellingham, WA, USA.

Evaluation and Examination Scheme

Evaluation Scheme 60:40
Internals Based on Unit 1 / Unit 2 / Unit 3/ Unit 4

Assignments/ Tutorials/Class Test	Seminar or any other activities	Ppt/video Presentation or any other activities	Group discussion/Book Review or any other activities	Active Participation & Leadership qualities	Total
10	10	10	05	05	40

Theory Examinations: For Paper 1, Paper 2, Paper 3 and Research Methodology

Suggested Format for MAJOR Question paper

Duration: 2½ Hours **Total Marks: 60**

All questions are compulsory

Q. 1	Answer ***any two*** of the following-		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following-		**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Answer ***any two*** of the following-		**12**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
Q. 4	Answer ***any two*** of the following-		
	a	Based on Unit IV	**12**
	b	Based on Unit IV	
	c	Based on Unit IV	
	d	Based on Unit IV	
Q. 5	Write a short note on ***any four*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	
	e	Based on Unit III	
	f	Based on Unit III	
	g	Based on Unit IV	
	h	Based on Unit IV	

Theory Examinations: For ELECTIVE Paper

Duration: 1.0 Hours **Total Marks: 30**

All questions are compulsory

Q. 1	Answer ***any two*** of the following-		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following-		**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Write a short note on ***any two*** of the following-		**06**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	

Semester End Practical Examination:

Practical examination of each paper for 50 marks will be held for three and half hours.

Semester ____ Practical Examination "Month & Year"

Paper Code: - _____

Total Duration: - 3 ½ hrs. **Total Marks**: - 50

Distribution of marks

Q. No. 1 - (performance & result/identification) – 25 marks
Q. No. 2 - (performance & result/identification) – 15 marks
Q. No. 3 - (viva voce) – 05 marks
Q. No. 4 - (journal/field report) – 05 marks

(This is sample paper pattern for practical. It can be changed by the department/college as per the prescribed practical given in syllabus)

Marks Distribution and Passing Criterion for Each Semester

Theory						Practical		
Course Code SEM I / SEM II	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
23BPEV1T1/2T1	40	16	60	24	100	-	-	-
23BPEV1T2/2T2	40	16	60	24	100	-	-	-
23BPEV1T3/2T3	40	16	60	24	100	-	-	-
Laboratory 1	-	-	-	-	-	23BPEV1P1/2P1	50	20
23BPEV1T4 or 1T5/2T4 or 2T5	20	08	30	12	50			
Laboratory 2	-	-	-	-	-	23BPEV1P2 or 1P3/2P2 or 2P3	50	20
23BPRM1T6	40	16	60	24	100	-	-	-

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project-based learning/case studies/self-study like seminar, term paper or MOOC

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