

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M.Sc (Environmental Science)

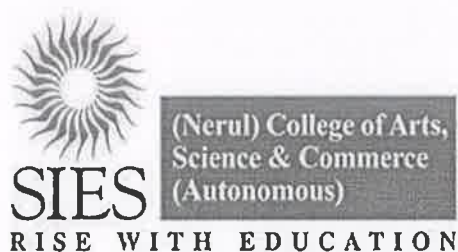
Sr. No.	Heading	Particulars
1	Title of the course	M.Sc (Environmental Science)
2	Eligibility for admission	A learner who has passed B.Sc. degree Examination of University of Mumbai or any other recognized university is eligible for the entrance examination. The learner must have secured minimum 50% marks (40% for the candidate belonging to reserved category) or equivalent grade at B.Sc examination in Chemistry, Botany, Zoology, Biotechnology, Microbiology, Life sciences, Biochemistry, Geology, Geography, Natural science, Agricultural Science or B.Sc degree with any other subject with Biological Science as one of the subject at F.Y./S.Y. level or B.E. degree of the university of Mumbai or any other University/institute recognised as equivalent or B.Sc in Vocational Course.
3	Passing Percentage	45% marks (40% for the candidate belonging to reserved category)
4	Semesters	Two semesters per year (Semester I)
5	Level	PG
6	Pattern	SEMESTER
7	To be implemented from	From Academic year 2024-25 in a progressive manner (Amendment)

Date: June 29, 2024

Signature:

Dr. Koel Roychoudhury
AC Chairperson

Dr. Jyoti G. Koliyar (Jatinder Das)
Head of the Department



SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
(Affiliated to University of Mumbai)

RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES

SYLLABUS FOR
M.Sc. Environmental Science

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

PROGRAMME OBJECTIVES:

1. To specialize students in different areas like conservation, ecology, biology and environmental chemistry.
2. To prepare students with the latest knowledge about Impact Assessments.
3. To prepare students with the strong knowledge about Environmental Sciences so that they can be eligible for various positions in educational institution, Industry, governmental and non-governmental organizations.
4. To make the students ready for research and promote them for higher studies.

PROGRAMME OUTCOMES:

PO1: Relate and apply fundamental knowledge of environmental science to factual world problem.

PO2: Analyse, identify and formulate actual services/solutions/applications with environmental requirements.

PO3: Implement, and evaluate environmental – based solution applicable to public health, ecological safety, environmental management and sustainable development considerations.

PO4: Understand management and environmental principles run into need of environmental sectors.

PO5: Select and use existing techniques, skills and tools to solve environmental issues by analyzing the local and global impact on the environment.

PO6: Distinguish a problem; plan a solution for the needs of the society in health, safety and environment applying relevant environmental practice.

PO7: Use of demonstrating techniques to design experiments, by analyzing and interpreting data.

PO8: Recognize the need of constant expertized improvement through lifelong learning.



SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M. Sc. Environment Science Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester I	Credits
<i>1</i>	<i>Major</i>		
1	M24ES1MJ01	Ecology, Ecosystem and Biodiversity	4
	M24ES1MJP01	Practical's in Ecology, Ecosystem and Biodiversity	2
2	M24ES1MJ02	Environmental Pollution	4
	M24ES1MJP02	Practical's in Environmental Pollution	2
3	M24ES1MJ03	Biodiversity and Conservation	2
<i>2</i>	<i>Electives(E)</i>		
4	M24ES1E01	Sustainability and Natural Resource Management	4
<i>3</i>	<i>Research Methodology</i>		
5	M24ES1RM01	Research Methodology	4
Total Credits			22



Ecology, Ecosystem and Biodiversity

COURSE CODE : M24ES1MJ01 COURSE CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate between the concept of principle and scope of ecology.
2. To predict the aspects of Biomes, Populations, Littoral Zones, Marine Environment and Dynamic Biogeography.
3. To analyze the components of the ecosystem and assess the concept of flow of energy in the ecosystem and succession related to ecology.
4. To discriminate the concept of Biodiversity and its components and predict the values of biodiversity and its status.

Course Outcomes:

1. To Understand and Differentiate Core Ecological Concepts.
2. To Analyze Population and Ecosystem Dynamics.
3. To Examine Energy Flow and Ecological Processes
4. To Evaluate Biodiversity and Conservation Strategies

Sr. No	Syllabus	No. of lectures
01	Module-1- Ecology Definition, principle and scope of ecology, aquatic and terrestrial ecology, freshwater ecology, marine ecology, estuarine ecology, Community concept, types of community, succession process, competition and Coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth.	15
02	Module 2-Biosphere and Ecosystem Biomes, Population parameters, structure, Growth Regulation, Interaction between populations, life, history, strategies. Types of ecosystem, ecosystem of India, Characteristics of ecosystem, structure of ecosystem and function of an ecosystem, population Dynamics,	15



	<p>Carrying capacity. Abiotic and Biotic environment, limiting factors, adaptation, Habitat and niche, nature of environment. Littoral Zones: Fauna of intertidal zones, their distribution and adaptations, ecological importance of mangrove vegetation, distribution of mangrove areas in India, salinity ingress in coastal areas.</p> <p>Marine Environment: Biota in different types of zones, its diversity-plankton, nekton, benthos, their adaptations and productivity, Indian marine territory, Exclusive Economic Zones (EEZ)</p> <p>Dynamic biogeography: routes of migration of plants and animals, their impact on local ecosystems, trade routes, shipping, accidental import, weeds, ballast water.</p>	
03	<p>Module 3- Organization of Ecological System, Energy and Ecological Succession</p> <p>Ecosystem components, Producers, consumers and decomposer,</p> <p>Food chains, food web and ecological pyramids, Biotic and abiotic components, Ecological pyramids,</p> <p>Bioaccumulation and biomagnifications, mass and energy transfer in successive trophic level, Ecosystem Services, Ecological Footprint, Biocapacity, Quantification of Ecological Footprint.</p> <p>Flow and energy fixation, construction of ecological pyramids, Biogeochemical cycles: Hydrological cycles, carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle, phosphorus cycle-its importance and applications. Biogeochemical Cycles with perspective to Organisms, Perspectives of Sustainability, Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, community ecology, predator and prey relationship.</p>	15



04	Module 4- Biodiversity concept, components and evaluation Biodiversity concept, Biodiversity-components, Biodiversity-Types, Biodiversity-values, ecological importance, economical importance, key stone umbrella and flagship species, Economic value of biodiversity, ecotone and niche. Biodiversity Hotspot, Wildlife Act, CBD, AICH Biodiversity targets Biodiversity status: National status and Global status, hotspot; threatened species, IUCN Category, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species. Climate change induced losses. common flora and fauna in India-Aquatic: phytoplankton, Zooplankton and macrophytes. Terrestrial: Forests; Endangered and threatened species.	15
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Practicals

COURSE CODE	TITLE	CREDITS	HOURS
M24ES1MJP01	Ecology, Ecosystem and Biodiversity	2	30

A. Minor Experiments

1. Determination of diversity indices in plant communities.
2. To construct ecological pyramids of population sizes in ecosystems.
3. Determination of Chlorophyll content from plant species.
4. Determination of Harvest method from plant species.
5. Identification and description of plant species.
6. Quantitative measurement of plankton in fresh and marine water samples.
7. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters.
8. To plot biosphere reserves on a map of India.

B. Major Experiments

1. To compare two plant communities
2. Determination of Importance value index of species in a plant community.
3. Determination of primary productivity by light and dark bottle method.
4. To analyze the carbon sequestration of plant species.
5. To study qualitative and quantitative characters of a plant community by quadrat method.
6. To study a plant community by using line transects method, using line, belt and profile transects.
7. Prepare a map of Maharashtra showing Protected Area Network (PAN) in it.
8. Indicate distribution range of a plant and animal species identified as endangered on an Indian map.



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 Del-hi.
- 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)
- 13) Environmental Biotechnology-Alan Scragg,Oxford University Press.
- 14) Sustaining Life: How Human Health Depends on Biodiversity Eric Chivian Aaron Bernstein (2008)
- 15) Shahid Naeem, Daniel E. Bunker, Andy Hector and Michel Loreau (2009)Biodiversity, ecosystem fuctioning and human well being: An ecological and economic perspective
- 16) S.K. Agarwal et al (1996) Biodiversity and Environment, APH, Dehra Dun.



Environmental Pollution

COURSE CODE : M24ES1MJ02 COURSE CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate sources and types of Air and Water Pollution.
2. To compare sources, causes and effects of soil pollution, solid waste and Plastic pollution.
3. To understand the concept of Radioactivity and Noise with sources and effects of radioactive and noise pollution
4. To identify the concept, sources, effects of Thermal pollution, Oil Pollution, Electronic waste and Plastic pollution.

Course Outcomes:

1. Students will be able to categorize and identify the various sources and types of air and water pollution, and analyze their impacts on environmental health and ecosystems.
2. Students will develop the ability to compare and contrast the sources, causes, and effects of soil pollution, solid waste pollution, and plastic pollution, enabling them to propose sustainable solutions.
3. Students will gain knowledge of the fundamental concepts of radioactivity and noise, along with identifying their sources, evaluating their effects, and understanding potential mitigation techniques.
4. Students will acquire skills to recognize the concept, sources, and consequences of thermal pollution, oil pollution, electronic waste, and plastic pollution, fostering awareness of preventive and control measures.

Sr. No	Syllabus	No. of lectures
01	Module 1- Environmental pollution, Air and Water Pollution: Definition and sources of pollution; Different types of pollution and their global, regional and local aspects. Types and sources of air pollutants smog, Atmospheric diffusion and stack performance; Transport of pollutants; Effects of air pollutants on flora, fauna and humans; Sinks of atmospheric gases. Acid rain, Photochemical smog, greenhouse effect Basic properties of sound waves – plane and spherical waves, sound pressure, loudness and intensity levels, decibel; Sources of Noise Pollution, Effects of noise pollution. Sources of water, types (Physical, Chemical, Biological) and sources of water pollution; Classification of water pollutants, Characteristics of various industrial effluents such as pulp and paper mills, petrochemicals, iron and steel industries, Effect of water pollution on environment and humans. Eutrophication - causes and effects and control measures.	15



02	<p>Module 2-Soil pollution, solid waste pollution and Biomedical waste:</p> <p>Importance of soil, composition of soil, Causes of soil pollution Various sources of soil pollution and their effects: Industrial waste, Urban waste, radioactive pollutants, agricultural practices, mining. Residual toxicity and pollution. Different kinds of synthetic fertilizers (N, P, K), and their interactions with different components of soil, their toxicity, and pollution. Solid waste pollution: sources, nature, classification and environmental effects. Biomedical Waste: Definition, Sources of generation, categories, colour coding system for segregation, Effects of biomedical waste on Human and Environment</p>	15
03	<p>Module 3- Nuclear and Hazardous waste pollution</p> <p>Radioactive substances; Interaction of radiation with matter; Units of radioactivity and radiation dose. Sources of radioactive pollution: Natural sources (solar rays, Environmental radiation, radionuclides in Earth's crust, Internal radiation), Anthropogenic sources (medical, nuclear tests, radioactive fallout, nuclear reactor, nuclear power etc.) Effects of various radiation. Effects of radioactive pollutants on the environment and humans.</p> <p>Definition, characteristics, classification, sources of hazardous waste. Effects of hazardous waste on environmental components. Concept of Bioaccumulation and Biomagnification</p>	15
04	<p>Module 4-Thermal pollution, Oil Pollution, Plastic pollution and Electronic waste (E-waste):</p> <p>Definition and various sources of thermal pollution, Chemical and biological effects of thermal pollution, Effect on marine life, bacteria and water quality and other aquatic biota. Sources of oil pollution, factors affecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, remote sensing in water quality monitoring. Sources, causes and effects of plastic pollution on various environmental components. Sources and types and constituents of E-wastes and its environmental consequences.</p>	15



COURSE CODE	TITLE	CREDITS	HOURS
M24ES1MJP02	Environmental Pollution	2	30
A. Minor Experiments 1. Determination of Total Dissolved Solids from the lake water. 2. Determination of Total Hardness of well water. 3. Measurement of photo density flux by Luxmeter. 4. Measurement and classification of noise pollution. 5. Determination of total organic matter in soil. 6. Determination of CO ₂ in the atmosphere by volumetric method. B. Major Experiments 1. Determination of pH, conductivity, and water-holding capacity of different types of soil. 2. Determination of physical parameters of (i) Well water (ii) Industrial of given type effluent (iii) River water (iv) Sea water. 3. Determination of Dissolved Oxygen from Seawater by Winkler's method. 4. Determination of Chemical Oxygen Demand value for industrial waste effluent 5. To study the soil profiles for their height, color, texture and electrical conductivity. 6. Determination of oil and grease			

References:

1. A Textbook of Environmental Chemistry and Pollution Control- Dr. SS Dara and Dr.DD Mishra
2. Air Pollution – Stern
3. Environmental Pollution Control Engineering: C. S. Rao
4. Environmental Chemistry: B.K. Sharma, and H. Kaur
5. Air pollution – threat and response: D. A. Lynn
6. Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication
7. J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.
8. Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
9. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.



Biodiversity and Conservation

COURSE CODE: M24ES1MJ03

COURSE CREDIT: 02 (Theory)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objective:

1. To analyze the national and international programmes and Acts for Biodiversity Conservation.
2. To plan different approaches for Biodiversity Conservation.

Course Outcomes:

CO1: Analyze key national and international programs and legal frameworks aimed at biodiversity conservation.

CO2: Design and evaluate strategic approaches and action plans for effective biodiversity conservation at various levels.

Sr. No	Syllabus	No. of lectures
1	Module 1- Biodiversity Conservation Importance of Biodiversity conservation, Different approaches for Biodiversity conservation-In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. 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.	15
2	Module 2- Biodiversity Convention Act IPRs, national and international programs for biodiversity conservation. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC, Aichi Biodiversity Targets under Convention on Biological Diversity (CBD), Wildlife Protection Act 1972. Joint Forest Management, People's Biodiversity Register, Current regulations, status and Case Studies of Biodiversity Conservation Projects (flora and fauna) Speciation in PAN India, NAGOA protocol.	15



References:

- 1) S.S. Negi (1993) Biodiversity and its Conservation in India, Indus Publications, New Delhi.
- 2) W.W. Collins and C.O. Qualset (1998) Biodiversity in Agro-ecosystem, CRC, Boston.
- 3) V.K. Krishnamurthy (2003) Text Book of Biodiversity, Science Publisher, Chennai.
- 4) P.S. Ramakrishnan (2000) Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge, Oxford and IBH, New Delhi
- 5) Global Biodiversity strategy: WRI, IUCN & UNEP
- 6) Ecotourism and Sustainable Development: Singh; Abhijeet Pub



OE- Sustainability and Natural Resources Management

COURSE CODE: M24ES1E01

COURSE CREDIT: 04 (Theory)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objective:

1. To discriminate about Natural Resources and methods of Resource Conservation.
2. To study about Natural Capital for Sustainability and Ecosystem Services.
3. To classify Environmental Degradation and Natural Resources.
4. To recommend Sustainable Energy Resources, particularly the renewable and non-renewable resources

Course Outcomes:

CO1: Analyze different types of natural resources and evaluate various methods for their effective conservation.

CO2: Demonstrate an understanding of natural capital and assess the role of ecosystem services in promoting environmental sustainability.

CO3: Classify types of environmental degradation and correlate them with the exploitation of natural resources.

CO4: Recommend appropriate sustainable energy solutions by differentiating between renewable and non-renewable energy sources.

Sr. No	Syllabus	No. of lectures
01	Module -1- Introduction to Natural Resources Natural resource, Renewable Resources: sunlight, wind, water, forests, food and wildlife, Non-renewable Resources- coal, oil, and natural gas, and minerals. Causes of Degradation: Overexploitation, Pollution, Climate Change, Land Degradation. Methods of Resource Conservation- Reduce, Reuse, and Recycle, Sustainable Extraction and Harvesting, Energy Conservation, Integrated Management of Land, Water, forest, Nuclear Energy	15
02	Module -2- Ecosystem Services and Natural Capital for Sustainability Resources for production, regulating climate and water cycles, supporting biodiversity, and offering recreational and cultural benefits, economic growth with environmental protection and social well-being, Ecosystem Services- Provisioning services, Regulating Services, Supporting Services, Cultural Services, Agricultural Resources and Sustainable Economy, Natural Resources and tourism development.	15
03	Module-3 – Environmental Degradation and Natural Resources Climate Change- Changes in Temperature and Precipitation, Sea Level Rise, Ocean Acidification, Shifts in Ecosystems, Natural Disasters- hurricanes, cyclones, floods, wildfires, Droughts, Landslides and earthquakes, Infrastructure Damage, Degradation - Deforestation, Soil	15



	Erosion, Water Pollution, Overfishing, Land Degradation, food and water security, livelihoods, and overall ecosystem health and sustainability	
04	Module-4- Sustainable Energy and Natural Resource Management Energy Resources- Concept and Demand of Energy, Renewable and Non-renewable Sources, Use of Alternate Energy Sources. Wind Energy, Solar Energy, Water as a Source of Energy, Biofuels Production, Use and Overexploitation of Energy. Conservation of Natural Resources- Energy Conservation, Energy Efficiency, Renewable Energy Adoption, Sustainable Transportation, Responsible Consumption, , Tools and techniques for sustainable resource management- LCA, EIA, GIS, Sustainable Land Management (SLM), Payment for Ecosystem Services (PES), Participatory Approaches, Conservation Incentive Programs	15

References:

- 1) Environmental studies by R. Rajagopalan, Member, Governing Board, International Ocean Institute, Malta, Oxford university press
- 2) Renewable Energy - Environment and Development by Mhaeshwar Dayal, Konark Publication Private Limited
- 3) Non-Conventional Energy sources by S. N Kaul, A. R Bhalerao, R. K Trivedy, Current Publication
- 4) Fundamentals of Ecology by Madhab Chandra Dash, Satya Prakash Jha, Tata Mc graw Education Private Limited
- 5) Environmental Policy - Neil Kheti, Oxford book company
- 6) Environment and Development -B N Pandey and G K Kulkarni, A. P. H. Publishing Corporation
- 7) Green Energy Technologies - Utkarsh Sharma, Jnanada Prakashan



Research Methodology

COURSE CODE: M24ES1RM01

COURSE CREDIT: 04 (Theory)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objective:

1. To understand the Foundation of Research and Formulation
2. To understand the aspects of Research Design
3. To learn the concept of Documentation and scientific writing
4. To understand how to Interpretation of Data and Paper Writing

Course Outcomes:

CO1: Explain the fundamental principles of research and effectively formulate research problems.

CO2: Demonstrate a comprehensive understanding of research design and its various components.

CO3: Apply the principles of documentation and scientific writing in preparing structured research reports and proposals.

CO4: Interpret research data accurately and develop scientific papers in accordance with academic standards.

Sr. No	Syllabus	No. of lectures
01	Module-1 Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research, Concept, Construct, Definition, Variable, Research Process. Problem Identification & Formulation - Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.	15
02	Module-2 Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurement: Nominal, Ordinal, Interval, Ratio	15



03	Module-3 Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. Publishing the Paper: Rights and Permissions, How to Submit the Manuscript, How and When to Use Abbreviations, How to Write a thesis, Outcome of Research, Ethical issues in research	15
04	Module-4 Interpretation of Data and Paper Writing- Layout of a Research Paper, Journals in Environmental Sciences , Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc. Academic Databases for Environmental Science Discipline. Use of tools & techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/ Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	15

References:

1. Business Research Methods William G.Zikmund, B.J Babin, J.C. Carr, Atanu Adhikari, M.Griffin Cengage 8e 2016.
2. Business Analytics Albright Winston Cengage 5e 2015.
3. Research Methods for Business Students Fifth Edition Mark Saunders 2011.
4. Multivariate Data Analysis Hair Pearson 7e 2014.
5. Thesis & Assignment Writing–J Anderson, B.H. Dursten & M.Poole, Wiley Eastern, 1977
6. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.
7. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005.
8. Practical Research Methods, by Dawson, Catherine, 2002, UBS Publishers' Distributors New Delhi.
9. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
10. How to write and Publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
11. Survival skills for Scientists by Federico Rosei and Tudor Johnson, (Imperial College Press).
12. How to Research by Loraine Blaxter, Christina Hughes and Malcolm Tight, (Viva Books).
13. The Craft of Scientific Writing by Michael Alley, (Springer).
14. A Student's Guide to Methodology by Peter Clough and Cathy Nutbrown, (Sage Publications).
15. Probability and Statistics for Engineers and Scientists" by Sheldon Ross, (Elsevier Academic Press).
16. Research methodology techniques and methods by C L Kothari, New age International publishers.
17. Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
18. Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
19. Research Methodology- C. R. Kothari
20. Select references from the Internet



D) Scheme of Examination for 2 Credits shall be divided into two parts:-

• **Internal Assessment: 20 Marks**

Description	Marks
Internal tests of 10 marks each Q.1 Multiple choice Questions/True or False - 05 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 05 Marks	10
One Project and Viva voce/Presentation/Case studies/Assignments	05
Attendance and Class behavior	05
Total	20

• **External Assessment: 30 Marks**

Paper Pattern

Total Marks: 30

Q.1 Answer any 2 two questions from the following...(Based on Unit I) (10Marks)

- a. 05
- b. 05
- c. 05

Q.2 Answer any 2 two questions from the following... (Based on Unit II) (10Marks)

- a. 05
- b. 05
- c. 05

Q.2 Answer any five questions from the following...(Mixed Questions) (10Marks)

- a. 02
- b. 02
- c. 02
- d. 02
- e. 02
- f. 02
- g. 02
- h. 02



SCHEME OF EXAMINATION

The scheme of examination shall be divided into two parts:

- Internal assessment 40% i.e. 40 marks
- Semester end examination 60% i.e. 60 marks

(A) Internal Assessment 40 marks

Description	Marks
Internal tests of 20 marks each Q.1 Multiple choice Questions/True or False - 10 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 10 Marks	20
One Project and Viva voce/Presentation/Case studies/Assignments	15
Attendance and Class behavior	5
Total	40



(B) External Examination

M.Sc ENVIRONMENTAL SCIENCE

Maximum Marks: 60

Duration: 2¹/₂hr

Question 1: Unit I

Question 2: Unit II

Question 3: Unit III

Question 4: Unit IV

Question 5: Unit I to Unit IV (Mixed questions)

- Instructions: i. All Questions are compulsory
ii. All questions carry equal marks
iii. Draw neat and labeled diagrams wherever necessary

Q.1. Answer any two questions from the following (Based on Unit I) 12 Marks

- a. 06
- b. 06
- c. 06

Q.2. Answer any two questions from the following (Based on Unit II) 12 Marks

- a. 06
- b. 06
- c. 06

Q.3. Answer any two questions from the following (Based on Unit III) 12 Marks

- a. 06
- b. 06
- c. 06

Q.4. Answer any two questions from the following (Based on Unit IV) 12 Marks

- a. 06
- b. 06
- c. 06



Q.5. Answer any Four questions from the following (Mixed Questions)

12 Marks

- a. 03
- b. 03
- c. 03
- d. 03
- e. 03
- f. 03
- g. 03



(C) PRACTICAL EXAMINATION

Paper Pattern

1. **Major Experiment: 25 Marks**
2. **Minor Experiment: 15 Marks**
3. **Journal: 05 Marks**
4. **Viva Voce: 05 Marks**

NOTE:

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.



D) Scheme of Examination for 2 Credits shall be divided into two parts:-

• **Internal Assessment: 20 Marks**

Description	Marks
Internal tests of 10 marks each Q.1 Multiple choice Questions/True or False - 05 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 05 Marks	10
One Project and Viva voce/Presentation/Case studies/Assignments	05
Attendance and Class behavior	05
Total	20

• **External Assessment: 30 Marks**

Paper Pattern

Total Marks: 30

Q.1 Answer any 2 two questions from the following...(Based on Unit I) (10Marks)

- a. 05
- b. 05
- c. 05

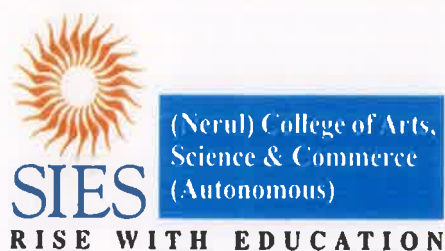
Q.2 Answer any 2 two questions from the following... (Based on Unit II) (10Marks)

- a. 05
- b. 05
- c. 05

Q.2 Answer any five questions from the following...(Mixed Questions) (10Marks)

- a. 02
- b. 02
- c. 02
- d. 02
- e. 02
- f. 02
- g. 02
- h. 02





SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M.Sc (Environmental Science)

Sr. No.	Heading	Particulars
1	Title of the course	M.Sc (Environmental Science)
2	Eligibility for admission	A learner who has passed B.Sc. degree Examination of University of Mumbai or any other recognized university is eligible for the entrance examination. The learner must have secured minimum 50% marks (40% for the candidate belonging to reserved category) or equivalent grade at B.Sc examination in Chemistry, Botany, Zoology, Biotechnology, Microbiology, Life sciences, Biochemistry, Geology, Geography, Natural science, Agricultural Science or B.Sc degree with any other subject with Biological Science as one of the subject at F.Y./S.Y. level or B.E. degree of the university of Mumbai or any other University/institute recognised as equivalent or B.Sc in Vocational Course.
3	Passing Percentage	45% marks (40% for the candidate belonging to reserved category)
4	Semesters	Two semesters per year (Semester II)
5	Level	PG
6	Pattern	SEMESTER
7	To be implemented from	From Academic year 2024-25 in a progressive manner (Amendment)

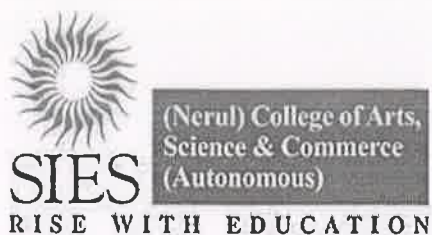
Date: June 29, 2024

Signature:

Dr. Koel Roychoudhury
AC Chairperson



Dr. Jyoti G. Koliyar (Jatinder Das)
Head of the Department



SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
(Affiliated to University of Mumbai)

RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES

SYLLABUS FOR
M.Sc. Environmental Science

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

PROGRAMME OBJECTIVES:

1. To specialize students in different areas like conservation, ecology, biology and environmental chemistry.
2. To prepare students with the latest knowledge about Impact Assessments.
3. To prepare students with the strong knowledge about Environmental Sciences so that they can be eligible for various positions in educational institution, Industry, governmental and non-governmental organizations.
4. To make the students ready for research and promote them for higher studies.

PROGRAMME OUTCOMES:

- PO1:** Relate and apply fundamental knowledge of environmental science to factual world problem.
- PO2:** Analyse, identify and formulate actual services/solutions/applications with environmental requirements.
- PO3:** Implement, and evaluate environmental – based solution applicable to public health, ecological safety, environmental management and sustainable development considerations.
- PO4:** Understand management and environmental principles run into need of environmental sectors.
- PO5:** Select and use existing techniques, skills and tools to solve environmental issues by analyzing the local and global impact on the environment.
- PO6:** Distinguish a problem; plan a solution for the needs of the society in health, safety and environment applying relevant environmental practice.
- PO7:** Use of demonstrating techniques to design experiments, by analyzing and interpreting data.
- PO8:** Recognize the need of constant expertized improvement through lifelong learning.



SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M. Sc. Environmental Sciences Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester II	Credits
1	Major		
1	M24ES2MJ01	Environmental Policies and Regulations	4
	M24ES2MJP01	Practical's in Environmental Policies and Regulations	2
2	M24ES2MJ02	Pollution Control Technology	4
	M24ES2MJP02	Practical's in Pollution Control Technology	2
3	M24ES2MJ03	Environmental Monitoring and Assessment	2
2	Electives(E)		
1	M24ES2E01	Green Technology	3
	M24ES2EP01	Practical's in Green Technology	1
	M24ES2E02	Water Pollution Monitoring, Control Technology and Management	4
3	OJT		
1	M24ES2OJT01	OJT	4
Total Credits			22



Environmental Policies and Regulations

COURSE CODE : M24ES2MJ01 COURSE CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate the evolution of environmental policy at the national and international levels.
2. To predict the values of environmental movements in India.
3. To evaluate the concept of International Environmental Treaties and Conventions related to conservation and protection of environment.
4. To recommend about Acts and Rules enforced to protect the environment.

Course Outcomes:

1. To understanding Environmental Laws and policies in India.
2. To learn about national and international movements connected with India.
3. To understand the International Environmental Treaties and Conventions.
4. To apply about Objectives and Provisions of Acts and Rules and its Amendments in policy and approach aimed at resolving environmental issues.

Sr. No	Syllabus	No. of lectures
01	Module-1- Evolution of International Environmental Policy <ul style="list-style-type: none">• Fundamental principles of environmental protection - sustainable development- Brundtland report 1987.• Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle, Public Trust Doctrine.• Constitutional Perspective: Fundamental right to wholesome environment. Directive principles of state policy. Fundamental duty.• National Environmental Policy.• Environmental Regulatory Framework in India.• Role of International Environmental Agencies -UNEP, GEF, UNFCCC and IPCC	15
02	Module 2- Environmental Movement In India <ul style="list-style-type: none">• Movements related to Environment Sacredgroves, Bishnoi tradition Chipko movement, Tehridam, Sardar Sarovar, Narmada dam Almatti dam, Silent Valley.• 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	15

03	MODULE III – International Environmental Treaties and Conventions <ul style="list-style-type: none"> ● Stockholm Conference on Human Environment, 1972 ● Ramsar Convention on Wetlands, 1971 ● Montreal Protocol, 1987 ● Basel Convention (1989, 1992) ● Earth Summit at Rio de Janeiro, 1992 ● Kyoto Protocol, 1997 ● Earth Summit at Johannesburg, 2002. ● Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. ● Convention on Desertification 1996 ● Convention on Biodiversity & Cartagena Protocol on Bio safety ● Climate Change and Agreements ● Paris Agreement ● CERP 	
04	MODULE IV- Objectives and Provisions of Acts and Rules and its Amendments <ul style="list-style-type: none"> ● Indian Forest Act 1927 ● Indian Wildlife (Protection) Act, 1972 ● Forest Conservation Act 1980 ● Forest Rights Act ● Water (Prevention and Control of Pollution) Act, 1974 ● Air (Prevention and Control of Pollution) Act 1981 ● Environment (Protection) Act, 1986 ● Public Liability Insurance Act, 1991 ● Bio-Medical Waste (Management & Handling) Rules, 1998 ● Noise Pollution (Regulation and Control) Rules, 2000 ● Municipal Solid Waste (Management and Handling Rules) 2000 ● Biodiversity Act 2002 ● Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003 ● EIA Notification 2006 ● The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 ● Wetland Rules 2009 • National Green Tribunal Act 2010 ● Coastal Regulation Zones (CRZ) Rules 2011. ● E-waste Management and Handling Rules 2011 ● Plastics Manufacture, Sale and Usage Rules, 2011 ● Recycled Plastics Manufacture and Usage Rules, 1999 ● VEANA convention, ● Earth Summit and Kyoto protocol-related agreements for climate action, ● Heat action plan, ● Smart city policy, ● Environmental NGT, ● Single-use plastic ban notification, 	15



Practicals

COURSE CODE	TITLE	CREDITS	HOURS
M24ES2MJP01	Practical's in Environmental Policies and Regulations	2	30
Major Experiments: <ol style="list-style-type: none"> 1. Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station). 2. Report on Eco-tourism. 3. Legal Case citation (Two per student) Minor Experiments: <ol style="list-style-type: none"> 1. Reports on various study tours/academic visits. 2. To attend/present research papers in National/International Conferences. 3. To collate the Environmental Data. 			

References:

- Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2005
- Leelakrishnan. P, 2008, Environmental Law Case Book ,Lexis Nexis, Butterworths
- Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co.Pvt. Ltd.
- Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow
- Singh Gurdip, 2004, Environmental Law in India, Mcmillan& Co.
- Shantakumar S,2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa& Company, Nagpur
- Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press (India)



Pollution Control Technology

● **COURSE CODE : M24ES2MJ02**

COURSE CREDIT: 04 (04 theory+02 practical)

● **1 credit - 15 lectures**

● **1 lecture is 60 minutes**

Course Objectives:

1. To discriminate the concept of Sewage and waste water treatment systems.
2. To identify the methods to control air pollution in the environment.
3. To assess solid waste, toxic waste, Hazardous waste and Radioactive waste disposal techniques and management.
4. To plan for measures to control Thermal pollution, Plastic pollution and Electronic waste (E-waste) and Noise pollution control techniques

Course Outcomes:

1. Identify and quantify the magnitude of various water pollution control technologies concerning sewage and wastewater treatment.
2. To apply various methods of air pollution control technique.
3. To identify various waste disposal techniques for pollution control.
4. To make use of various measures for thermal, plastic, E-waste and noise pollution control.

Sr. No	Syllabus	No. of lectures
01	Module 1- Water Pollution Control Technologies: Sewage and wastewater treatment systems; Primary, secondary (types of aerobic and anaerobic treatment processes), and tertiary treatments; Biological treatments - aerobic versus anaerobic treatments; Biofilms intreatment of wastewater; Bioreactors for wastewater treatments; Reactor types and design; Reactors in series. General scheme for the treatment of water for drinking purposes. Water Treatment: UV, H ₂ O ₂ , Ozonation, chemical precipitation, disinfection, Adsorption, softening, desalinization/demineralization, membrane processes. Concept of common effluent treatment plant (CETP) their importance and, advantages, and role in wastewater treatment. Unit processes involved. Effluent discharge standards, industry-specific minimum and national standards. Sludge types, Processing of sludges- conditioning thickening, dewatering, drying, incineration and disposal.	15
02	Module 2-Air pollution control technologies and devices Equipment and Basic Operating Principles; Gravity settling chamber, Centrifugal collectors- cyclone collector and dynamic precipitators; Electrostatic precipitators; Fabric filters. Limestone injection and fluidized bed combustion, Desulfurization, Absorption in liquids by Scrubbers, and adsorption on solids. Combustion: flaring, thermal incineration, catalytic oxidation. Odour control techniques stack monitoring, Indoor air quality management principles, and control measures, steps for improving indoor air quality. Control of auto-exhaust emissions. Emission-specific control options, use of afterburners.	15



	engine modifications, Catalytic converter and control of vehicular emission, the importance of good maintenance and driving habits.	
03	Module 3- Solid, Hazardous, Biomedical Waste and Radioactive Waste Management: solid waste management and disposal methods – open dumps, ocean dumping, Landfills, Incineration; Concept of seven Rs, Hazardous waste management; Safe storage, transport, and treatment of. Stabilization and disposal Criteria for selection of secured and unsecured landfill disposal sites. Physical, chemical, and Thermal treatment of hazardous waste treatment. Biomedical waste management; colour coding system for segregation, transportation specifications, treatment methods: Incineration, Microwave, Plasma Pyrolysis, Hydroclave etc Control and Management of radioactive waste: health and safety aspects. Types of radioactive wastes and their disposal, Near-surface disposal, Deep geological disposal etc.	15
04	Module 4-Thermal pollution, Plastic pollution and Electronic waste (E-waste) and Noise pollution control techniques Measures to Control Thermal Pollution; cooling towers, cooling ponds, artificial lakes, spray ponds and Cogeneration Plastic waste management; Recycling of waste plastic, mechanical and feedstock recycling, pyrolysis and waste to energy, landfill and other applications E-Waste; segregation, transportation, treatment methods Noise control at the source, control at the transmission path, Control At the Receiver End, law and regulations.	15

- References:
- 1. N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York.
- 2. Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2000.
- 3. Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
- 4. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
- 5. Mizrahi & Wezel, Advances in Biotechnological Process
- 6. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.
- 7. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999
- 8. Environmental Chemistry : B.K. Sharma, and H. Kaur.
- 9. Elements of Environmental Chemistry : H.V. Jadhav.
- 10. Environmental Chemistry : S. K. Banerjee.
- 11. A text book of Environmental Chemistry and Pollution Control : S.S.Dara.



COURSE CODE	TITLE	CREDITS	HOURS
M24ES2MJP02	Practical's in Pollution Control Technology	2	30

A. Minor Experiments

1. Determination of heavy metals (Fe/Cu) by spectrophotometric methods
2. Removal of suspended solids by sand filter method.
3. Detection/estimation of Cr (VI) in the presence of Cr (III)
4. Estimation of mixed liquor suspended solids (MLSS) and Sludge Volume Index (SVI) in activated sludge.
5. Determination of relative humidity from the atmosphere.
6. Determination of particulate matter from the industrial area by High Volume Sampler/Settling method.
7. Determination of Salinity of water by volhard's method.

B. Major Experiments

1. Determination of K₂O value of soil by flame photometer.
2. Determination of P₂O₅ from soil by Olson's colorimetric method.
3. Determination of Chlorine demand
4. Wastewater analysis for pH, conductivity, TDS, DO, COD, BOD, alkalinity, chloride and hardness.
5. Estimation of fluoride in waste samples by spectrophotometry.
6. To prepare the station based wind rose for an area.
7. Determination of Residual Chlorine from drinking water using colorimetric method



Environmental Monitoring and Assessment

COURSE CODE : M24ES2MJ03 COURSE CREDIT: 02 (Theory)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate the information on methods and advantages of Environmental Monitoring
2. To gain information about Environmental Impact Assessment

Course Outcomes:

1. To understand about the Environmental Monitoring
2. To Obtain basic capability in skills and functional knowledge to carry out Environmental Impact Assessment based project

Sr. No	Syllabus	No. of lectures
01	MODULE 1- Environmental Monitoring: What is environmental quality? Quality of environment for life on earth and man; Advantages of Environmental Monitoring, Deterioration of environmental quality with reference to anthropogenic impact; Methods of assessment of environmental quality; Short term studies/surveys Rapid assessment; Continuous short and long term monitoring	15
02	MODULE-II- Environmental Impact Assessment (EIA) Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies; Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, and system diagram technique; Merits and Demerits of EIA studies.	15

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



Elective- Green Technology

COURSE CODE : M24ES2E01 COURSE CREDIT: 04 (03 theory+01 practical)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate green chemistry, principle, concepts and tools of green technology.
2. To classify the concept of catalytic methods of green synthesis, different basic approaches of safer chemicals, selection of Auxiliary substances and designing of biodegradable products.
3. To apply green nanotechnologies for resource conservation, ecosystems and human.

Course Outcomes:

1. To realize the importance of green technologies in sustainable growth of Industry and society.
2. To understand the concept of Green Nanotechnology.
3. To learn about the applications in Green technology.

Sr. No	Syllabus	No. of lectures
01	Module -1- Overview, Principle, concepts and Tools of Green technology: Overview of green chemistry, Chemistry of the atmosphere, principles of sustainable and green chemistry. Basic principles of green technology concepts of atom economy and carbon trading, tools of green technology waste minimization and climate change, Zero waste technology, concept of environmentally balanced industrial complexing and industrial ecology, green house effect, climate change, photochemical smog 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 selection of starting materials; use of blocking/protecting groups, catalytic reagents; designing of biodegradable products.	15
02	Module-3 – Green Nanotechnology: Introduction to Nanomaterials and green nanotechnology, Fullerene, carbon nanotubes, Nanoparticles; Green nanoparticle production and characterization; Biocompatibility; Nanomaterial applications of green nanotechnologies; use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems and human	15



03	Module 3-Green technology applications: Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, Pollution free engineering processes.	15
04	Practical's in Green Technology Minor Experiments <ol style="list-style-type: none"> 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. To Study the chemical reactions involved in green nanotechnology: Nanoparticle production and characterization. Major Experiments <ol style="list-style-type: none"> 1. Extraction and separation of organic compounds from soil and biological materials a. Ammonium sulphate method (Nichols method), b. TCA method, c. Acid digestion method, d. Wet washing for metals, e. Steam distillation for volatiles 2. 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. 3. Biofuel production methods and characterization for biodiesel and bioethanol. 	15

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



Elective-02: Water Pollution Monitoring, Control Technology and Management

COURSE CODE : M24ES2E02

COURSE CREDIT: 04 (Theory)

1 credit - 15 lectures

1 lecture: 60 minutes

Course Objectives:

1. To discriminate the concept of Waste Water Management
2. To identify the methods to control water pollution in the environment.
3. To understand the concept of waste water treatment methods.
4. To understand the concept of treatment of waste water.

Course Outcomes:

1. To learn about the concept of Waste Water Management
2. To learn the methods to control water pollution in the environment.
3. To learn the concept of waste water treatment methods.
4. To apply the concept of treatment of waste water.

Sr. No	Syllabus	No. of lectures
01	Module-I- Generation of Waste Water, Categories of Waste Water and their Characteristics, Waste Water Management	15
02	Module – 2- Waste Water Sampling and Monitoring, methods of analysis, determination of Organic Matter, Inorganic Substances, Physical Characteristics, concept of oxygen demand-DO, BOD, COD and bacterial measurements	15
03	Module-3 –Waste water treatment, Basic processes of primary treatments, Pre-treatment, sedimentation and floatation	15
04	Module-4- Secondary Treatments, Activated Sludge process, Trickling filter, Rotating biological Contractors, Sludge Treatment and disposal. Advanced waste water treatment, N-removal, P-removal, Advanced Biological Systems, Chemical Oxidation, Removal of Suspended Solids, dissolved solids.	15

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 An-drew 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 & Wézel, 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.



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

Students are expected to spend a minimum of **30 days during their semester break** under the guidance of a competent professional/ scientist at a research institute or research centre with the aim of learning techniques and their applications Or internship in industry/ consultancy/ NGO.

The assessments should be based on supervisor's feedback, submission of a training report and an open presentation and Viva voce.



SCHEME OF EXAMINATION

The scheme of examination shall be divided into two parts:

- Internal assessment 40% i.e. 40 marks
- Semester end examination 60% i.e. 60 marks

(A) Internal Assessment 40 marks

Description	Marks
Internal tests of 20 marks each	20
Q.1 Multiple choice Questions/True or False - 10 Marks	
Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 10 Marks	
One Project and Viva voce/Presentation/Case studies/Assignments	15
Attendance and Class behavior	5
Total	40



(B) External Examination

M.Sc in ENVIRONMENTAL SCIENCES

Maximum Marks: 60

Duration: 2¹/₂ hr

Question 1: Unit I

Question 2: Unit II

Question 3: Unit III

Question 4: Unit IV

Question 5: Unit I to Unit IV (Mixed questions)

Instructions: i. All Questions are compulsory

ii. All questions carry equal marks

iii. Draw neat and labeled diagrams wherever necessary

Q.1. Answer any two questions from the following (Based on Unit I)

a. 06

b. 06

c. 06

Q.2. Answer any two questions from the following (Based on Unit II)

a. 06

b. 06

c. 06

Q.3. Answer any two questions from the following (Based on Unit III)

a. 06

b. 06

c. 06

Q.4. Answer any two questions from the following (Based on Unit IV)

a. 06

b. 06

c. 06

Q.5. Answer any two questions from the following (Mixed Questions)

a. 03

b. 03

c. 03

d. 03

e. 03

f. 03



(C) PRACTICAL EXAMINATION

Paper Pattern

1. **Major Experiment: 25 Marks**
2. **Minor Experiment: 15 Marks**
3. **Journal: 05 Marks**
4. **Viva Voce: 05 Marks**

NOTE:

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.

(D) Elective:

Green Technology: (50 Marks Theory and 50 Marks Practical)

