

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

M.Sc (Environmental Sciences)

Sr. No.	Heading	Particulars
1	Title of the course	M.Sc (Environmental Sciences)
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 45% 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	40%
4	Semesters	Two semesters per year
5	Level	PG
6	Pattern	SEMESTER
7	To be implemented from	From Academic year 2023-24 in a progressive manner



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 Sciences

(WITH EFFECT FROM THE ACADEMIC YEAR 2023-2024)

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- 2023-24)

No. of Courses	Course Code	Semester I	Credits
1	Major		
1	M23ES1MJ01	Ecology, Ecosystem and Biodiversity	6
2	M23ES1MJ02	Environmental Pollution	6
3	M23ES1MJ03	Biodiversity and Conservation	2
2	Electives(E)		
4	M23ES1E01	Sustainability and Natural Resource Management	4
3	Research Methodology		
5	M23ES1RM01	Research Methodology	4
Total Credits			22

Ecology, Ecosystem and Biodiversity

COURSE CODE : **M23ES1MJ01** **COURSE**
CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objective:

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.

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, Carrying capacity. Abiotic and Biotic environment, limiting factors, adaptation, Habitat and niche, nature of	15

	<p>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, AICHI 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
	Ecology, Ecosystem and Biodiversity	2	30
<p>A. Minor Experiments</p> <ol style="list-style-type: none"> 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. <p>B. Major Experiments</p> <ol style="list-style-type: none"> 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 transect 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 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)
- 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 functioning 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: M23ES1MJ02 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.

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	Module 2-Soil pollution, solid waste pollution and Biomedical waste:	15

	<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.</p> <p>Solid waste pollution: sources, nature, classification and environmental effects.</p> <p>Biomedical Waste: Definition, Sources of generation, categories, colour coding system for segregation, Effects of biomedical waste on Human and Environment</p>	
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.</p> <p>Sources of oil pollution, factors affecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, remote sensing in water quality monitoring.</p> <p>Sources, causes and effects of plastic pollution on various environmental components.</p> <p>Sources and types and constituents of E-wastes and its environmental consequences.</p>	15

COURSE CODE	TITLE	CREDITS	HOURS
	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.

OE- Sustainability and Natural Resources Management

COURSE CODE:M23ES1E01

COURSE CREDIT: 04

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

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	15

	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 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 Mcgraw 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:M23ES1RM01

COURSE CREDIT: 04

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**

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 measurementNominal, Ordinal, Interval, Ratio	15
03	Module-3-	15

	<p>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.</p> <p>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</p>	
04	<p>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 I 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</p>	15

Books and 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 Malcum 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

Biodiversity and Conservation

COURSE CODE: M23ES1MJ03

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.

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

