

# DEPARTMENT OF ENVIRONMENTAL STUDIES

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## FACULTY OF SCIENCE

### **Proposed Syllabus for MSC in Environmental Science** (Effective from Academic Year 2020-21)



THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA  
VADODARA-390002, GUJARAT, INDIA



H. H. Maharaja Sayajirao Gaekwad-III

### MISSION STATEMENT

Vision and mission as perceived by  
H. H. Maharaja Sayajirao Gaekwad-III

*“The progress of a nation requires that its people  
should be educated. Knowledge is a necessity of man.*

*It instills in him a desire to question and to investigate, which leads him on  
the path of progress. Education, in the broadest sense, must be spread everywhere.*

*Progress can only be achieved by the spread of education. Cooperation is  
necessary to achieve any worthy end and this readiness to  
cooperate will not be found in people if they are not educated.*

*We are here on a mission  
Do not get tired, get exhausted*

The Department of Environmental Studies began its glorious existence under *UGC Innovative Program* as a self-finance program of B.Sc. (Hons) Environment Science in the year 2000 and later introduced M.Sc. (2010) and Ph.D. (2016) programs. *The Department is celebrating beginning of its 3<sup>rd</sup> decade of existence with successful accomplishments of educational and societal commitments.*

### **New Course Proposal**

Environmental Science is a trans-disciplinary course and therefore, the syllabus has been upgraded with the advancement in various fields of allied sciences. Present MSC in Environmental Science course has been modified **with effect from the academic year 2020-21**, progressively. The inputs from industries and various stake holders were considered to draft an advance course structure.


1. The first semester syllabus has been drafted to develop understanding and interest in subject needs of environmental sciences including ecology, natural resources and toxicology. Since MSC course has dissertation as one of the important component, Research Methodologies are included here.
2. The second semester syllabus has been drafted to progressive address the environmental pollution and management components in theory and practical to develop on hand skill in environmental assessment and nanotechnology and plasma science applications.
3. In the third semester, remote sensing, impact assessment and auditing, environmental legislation and related components are incorporated.
4. The fourth semester is completely devoted for dissertation. **We encourage students to take up the dissertation subjects such that they are able to present the findings in a conference and publish it in good scientific journal.**

### MSC in Environmental Science: Course Brief


Course Code	Course	Credits
<b>First Semester (FSMSC – Previous)</b>		
ENV 2101	Research Methodology and Instrumentation	4
ENV 2102	Toxicology and Hazardous Waste	4
ENV 2103	Ecology	4
ENV 2104	Environmental Resources and Sustainable Development	4
ENV 2105	Practical I - Biostatistics, Computer Applications and Instrumentation training	3
ENV 2106	Practical II - Toxicology and Waste Analysis	3
ENV 2107	Practical III - Ecology	3
ENV 2108	Field Visit (to Environmental Pollution, Waste Disposal and Treatment Sites)	2
ENV 2109	Seminar (on Current Environmental Challenges and Technology Advances)	1
	Total Credits	28
<b>Second Semester (SSMSC – Previous)</b>		
ENV 2201	Nanotechnology, Plasma Science and Biotechnology	4
ENV 2202	Ecological Assessment and Conservation	4
ENV 2203	Air and Noise Pollution Monitoring and Management	4
ENV 2204	Water and Soil Pollution Monitoring and Management	4
ENV 2205	Practical IV - Nanotechnology and Biotechnology	3
ENV 2206	Practical V - Analysis of Pollution Indicators	3
ENV 2207	Practical VI – Ecological Assessment and Conservation	3
ENV 2208	Field Visit (to Biodiversity and Conservation sites, to pollution impacted sites)	2
ENV 2209	Seminar presentation on a research article	1
	Total Credits	28

<b>Course Code</b>	<b>Course</b>	<b>Credits</b>
<b>Third Semester (FSMSC – Final)</b>		
ENV 2301	Remote Sensing and GIS Applications	4
ENV 2302	Impact Assessment, Auditing and Environmental Economics	4
ENV 2303	Industrial Safety, Risk Assessment and Disaster Management	4
ENV 2304	Environmental Applications and Environmental Legislation	4
ENV 2305	Practical VII - RS and GIS	3
ENV 2306	Practical VIII - EIA Case Studies, Awareness and Socio-Economic Studies	3
ENV 2307	Practical IX - Industrial Safety, Environ Monitoring and Modelling	3
ENV 2308	Industrial/Institutional Visit	1
ENV 2309	Seminar on Dissertation Proposal	2
	Total Credits	28
<b>Fourth Semester (SSMSC – Final)</b>		
ENV 2401	Pre Dissertation Seminar on Experimental Design and Methodology	2
ENV 2402	Dissertation Submission Assessment	4
ENV 2403	Dissertation Presentation Assessment	6
ENV 2404	Comprehensive Viva Voce	4
	Total Credits	16


## Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
	M.Sc. Environmental Science: Higher Payment Programme			
Year	I	Core ENV2101C01: RESEARCH METHODOLOGY AND INSTRUMENTATION	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lecture, Tutorial and Assignments.		
Unit No.	Topic/Unit			
1	<b>Research Methodology</b> <ul style="list-style-type: none"> <li>• Philosophy of and motivation for research.</li> <li>• Types of research: Lab based, Field based and Survey based: strategies for case studies</li> <li>• Preparation of Research Questions and Hypothesis</li> <li>• Framing aim and objectives, importance of methodology</li> <li>• Sampling types, Data: sources, structures, types and collection.</li> <li>• Components of research proposal</li> </ul>			
2	<b>Scientific Writing and ethics</b> <ul style="list-style-type: none"> <li>• Description, value, and development of points/outlines before writing.</li> <li>• Screening of Material for inclusion within the structure of the manuscript.</li> <li>• Outline structure and writing of research paper, review article, scientific report and thesis.</li> <li>• Bibliography and Referencing</li> <li>• Moral and Ethics in scientific writing:</li> <li>• Fabrication, falsification and Plagiarism in research</li> <li>• Paraphrasing and copy write violation and consequences of these</li> <li>• Intellectual Property Right</li> </ul>			
3	Application of Biostatistics <ul style="list-style-type: none"> <li>• Measurements of central tendency</li> <li>• Statistical Methods: Standard deviation and variance.</li> </ul>			


	<ul style="list-style-type: none"> <li>• Basic concepts: Measures of central tendency and deviations</li> <li>• Types of Probability, Normal and Binomial Distribution.</li> <li>• Hypothesis testing, significance and correlations: Linear models and regressions.</li> <li>• Multiple regressions. Difference among means: univariate and multivariate analysis; F-test: ANOVA, T-test, FUZZI technology, Analytical Hierarchy Process</li> </ul>
4	<p>Analytical Techniques</p> <ul style="list-style-type: none"> <li>• Sampling and sampling design.</li> <li>• Solvent Extraction and chromatography</li> <li>• Spectroscopic analysis, Centrifugation and Electrophoresis</li> <li>• Advancement and environmental application of GC and HPLC</li> <li>• Advanced Analytical Techniques</li> </ul>
	<p>Assignments:</p> <p>The assignments are to reconsolidate fundamentals and their applicability, therefore, are not given separate weightage for examination purpose.</p> <p>Assignments pertaining to integration of experimental design (based on primary and/or secondary data), statistical tools as well as the advances in environmental analytics.</p>
Reference Books	
1	Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
2	Ott W.R. (1995). Environmental Statistics and Data Analysis, CRC Press.
3	Whitlock, M. C., & Schluter, D. (2009). The analysis of biological data (No. 574.015195 W5).
4	Anderson, J., Poole, M. E., & Durston, B. H. (1970). Thesis and assignment writing. J. Wiley and Sons Australasia.
5	Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC Press
6	Skog D.A., Holler E.J. and Crpuch S.R. (2007) Principals of Instrumental analysis, Thomson learning, Baba BarkhaNath Printers, Haryana, pp 1039.
7	Fifield F.W and Haines P. J. (2000) Environmental analytical chemical. Black well Science, pp 490.

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science: Higher Payment Programme				
Year	I	Core ENV2102C02: TOXICOLOGY AND HAZARDOUS WASTE	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lecture, Tutorial and Assignments.		
Unit No.	Topic/Unit			
1	(a) Environmental Toxicology <ul style="list-style-type: none"> <li>• Toxicant inputs, their global disposition, fate and behaviour in the environment: individual chemical and chemical mixtures</li> <li>• Quantifying and measuring eco-toxicological impacts: Abiotic and biotic indicators of aquatic and terrestrial ecosystems. Mechanisms and impacts of bioaccumulation, bioconcentration and Biomagnification</li> <li>• Toxic agents and their environmental hazards: Pesticides, metals, radiation and radioactive materials</li> <li>• Effect of endocrine disruptive chemicals on wildlife</li> <li>• Assessing risk associated with pollution</li> <li>• Interconnections between ecosystem integrity and human health</li> </ul> (b) Occupational Toxicology <ul style="list-style-type: none"> <li>• Types of occupational hazards</li> <li>• Workplace exposures and Standards</li> <li>• Occupational injuries and diseases: Basic functioning of respiratory, hepatic and renal systems, characteristics of blood with reference to toxicant exposure, load and removal</li> <li>• Toxicological evaluation of occupational agents and exposure monitoring: particulates, aerosols, solvents and vapors</li> <li>• Worker health surveillance for prevention of occupational diseases and health care services</li> <li>• Occupational health and safety issues in different types of industries and legislation in India</li> </ul>			
2	(a) Solid and Hazardous Waste <ul style="list-style-type: none"> <li>• Classification, characterization and processing of municipal solid and hazardous waste</li> <li>• Hazardous waste treatment, storage, transportation and disposal Facilities</li> </ul>			


	<ul style="list-style-type: none"> <li>• Compatibility of hazardous wastes for disposal</li> <li>• Criteria for selection of hazardous waste disposal sites</li> <li>• Impacts of hazardous waste disposal and leachate on natural resources (particularly groundwater), wildlife and human health</li> </ul> <p>(b) Biomedical Waste</p> <ul style="list-style-type: none"> <li>• Characterization of biomedical waste, segregation, collection and transportation</li> <li>• Treatment and Disposal system and biomedical waste management</li> <li>• Health hazards of biomedical waste</li> </ul> <p>(c) Waste Management and Legislation</p> <ul style="list-style-type: none"> <li>• National and international strategies in solid, hazardous and biomedical waste management</li> <li>• Legislation for solid, hazardous and biomedical waste handling and disposal in India</li> <li>• Ecological footprints of waste management</li> </ul>
3	<p>The assignments are to reconsolidate fundamentals and their applicability, therefore, are not given separate weightage for examination purpose.</p> <p>The students will be given assignment to self-study following components:</p> <ul style="list-style-type: none"> <li>• Types of industrial settlements around Vadodara and their pollution potential.</li> <li>• Occupational health hazards to traffic police, safai sevaks, rag-pickers, security guards and night watchmen, etc.</li> <li>• Ecological and economic prospecting of municipal solid waste</li> </ul>
Reference Books	
1	Klaassen CD. Casarett and Doulls Toxicology, McGraw Hill, USA. 2010
2	Timbrell JA. Principles of Biochemical Toxicology, Informa Healthcare, USA. 2009
3	Hoffman DJ, Rattner BA, Burton GA, Cairns J. Handbook of Ecotoxicology Lewis Publishers, USA. 2002
4	Moeller D.W. (1992). Environmental Health, Harvard University press, London, pp 332.


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2020-2021
M.Sc. Environmental Science: Higher Payment Programme				
Year	I	Core ENV2103C03 : ECOLOGY	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lecture, Tutorial and Assignments.		
Unit No.	Topic/Unit			
1	Ecological Concepts <ul style="list-style-type: none"> <li>• Biogeography: Evolution, existence and extinction, Dispersal, distribution &amp; speciation, Mainland and island biogeography.</li> <li>• Biodiversity: Patterns, processes and characterization. Alpha, beta and gamma diversity, drivers of beta diversity, Ecosystem, species and genetic diversity, Global biodiversity strategy and Information Network. Biodiversity hotspots of India and world.</li> <li>• Food web interconnectivity of terrestrial and aquatic habitats as interlinks and interactions of biodiversity and ecological processes. Landscape connectivity</li> <li>• Community, ecosystem and landscape levels of ecological systems</li> </ul>			
2	Terrestrial Ecosystems <ul style="list-style-type: none"> <li>• Ecosystem characterization: Environmental variations, complexity and stability of terrestrial ecosystems (examples from Gujarat &amp; India).</li> <li>• Soil as Habitat: Nutrient availability and regeneration, moisture content, eutrophic and oligotrophic soils, role of organismic interactions, habitat conversions.</li> <li>• Vertical stratification, energy and productivity, resource partitioning, comparison of organismic density and distribution in various terrestrial ecosystems (examples from Gujarat &amp; India).</li> <li>• Ecological features of Indian terrestrial ecosystems: Himalayan, Western Ghats, Flood plain forests, Desert, Grasslands.</li> </ul>			
3	Freshwater Ecosystems <ul style="list-style-type: none"> <li>• Characterization of freshwater systems: lentic, lotic and estuarine systems.</li> <li>• Channel characteristics, hydrodynamics, micro habitat variations, river bed composition, riparian environment.</li> </ul>			


	<ul style="list-style-type: none"> <li>• Damming and other structural modifications led changes in the characteristics and environment of freshwater ecosystems.</li> </ul> <p>Marine Ecosystems</p> <ul style="list-style-type: none"> <li>• Oceanography and Hydrodynamics: geology, geohydrology, chemical and physical environment, composition of sea water and sea floor, ocean heating and cooling, ocean layers and ocean mixing. Tidal fluctuations, wave and current variations, influence of estuarine characteristics and riverine flow dynamics, characteristic features of gulfs (Gujarat and Indian examples with important world examples), coastal landforms.</li> <li>• Profile zoning and characteristic features of marine ecosystem: Intertidal area, Continental shelf, Neritic zone and Open sea.</li> <li>• Habitat characteristics: Geography, geochemistry and chemistry, variable environmental conditions in different zones and sub zones of rocky, sandy and muddy inter tidal areas. Physical and biotic zonation of intertidal areas, patterns and processes in the water column</li> <li>• Coral reef, mangrove systems</li> <li>• Estuary and marine swamps: Physical and chemical characteristics: slope, sediment composition and estuarine gradation, productivity and diversity peculiarities.</li> </ul>
4	<p>The assignments are to reconsolidate fundamentals and therefore, are not given separate weightage for examination purpose. The students will be given assignment to self-study following components:</p> <ul style="list-style-type: none"> <li>• Planktonic and benthic flora and fauna of inter tidal, sub tidal and near coastal regions</li> <li>• Threats to coral and mangrove ecosystems.</li> <li>• Global environmental changes and their influences on oceanic currents.</li> </ul>
Reference Books	
1	Smith TM and Smith RL. Elements of Ecology, Pearson Education Inc, USA. 2012
2	Molles MC: Ecology. Concepts and Applications, McGraw-Hill Education Inc, USA. 2013
3	Ricklefs RE. The Economy of Nature, WH Freeman & Co., USA. 2008
4	Tannenbaum LV. Ecological Risk Assessment: Innovative field and Laboratory Studies, CRC Press, USA. 2018
5	Jorgensen SE, Costanza R and Xu FL. Ecological Indicators for Assessment of Ecological Health, CRC Press, USA. 2005
6	Hunter ML and Gibbs JJ. Fundamentals of Conservation Biology, Blackwell Pub, USA. 2007
7	Levinton J. Marine Biology: Function, Biodiversity, Ecology, Oxford University Press. 2013
8	Karleskint G Jr, Turner R and Small JW Jr. Introduction to Marine Biology, 3 <sup>rd</sup> Ed. Brooks/Cole, Cengage Learning. 2010


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science: Higher Payment Programme				
Year	I	Core ENV2104C04: ENVIRONMENTAL RESOURCES AND SUSTAINABLE DEVELOPMENT	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lecture, Tutorial and Assignments.		
Unit No.	Topic/Unit			
1	<p>Environmental Resources</p> <ul style="list-style-type: none"> <li>• Aquatic resources: Geohydrology. Surface, subsurface and groundwater resources. Requirement, exploitation, conservation and budgeting of water resources.</li> <li>• Terrestrial resources: Forest, Grasslands, deserts as resources, development and management components, Urbanization challenges.</li> <li>• Minerals and mining resources management</li> <li>• Biodiversity as natural resources, Its over exploitation challenges</li> <li>• Energy Resources: Renewable and Non-renewable</li> <li>• Carbon, Nitrogen, Water, Energy and Ecological Footprints</li> </ul>			
2	<p>Sustainable Development</p> <ul style="list-style-type: none"> <li>• Concept of sustainable development and sustainability indicators</li> <li>• National economy, Environmental degradation and sustainable development</li> <li>• Resource modelling for sustainability</li> <li>• Modelling for comprehensive urban sustainability</li> <li>• World Trade Organization: Measures taken by WTO in trade affairs and improving environment Environmental legislations, institutions and policies with special reference to India.</li> <li>• Innovation strategies for sustainable development</li> <li>• Governance for sustainable development</li> </ul>			


	<ul style="list-style-type: none"> <li>• Policy responses to environmental degradation and sustainable development</li> </ul>
3	<p>The assignments are to reconsolidate fundamentals and therefore, are not given separate weightage for examination purpose. The students will be given assignment to self-study following components:</p> <ul style="list-style-type: none"> <li>• Integrated Pest Management</li> <li>• Social forestry</li> <li>• Sustainable exploitation of aquatic food resources</li> <li>• Feasibility of utilization of renewable energy resources and development of green buildings in Vadodara.</li> <li>• Waste segregation and community composting in educational institutes of Vadodara</li> <li>• Rain water harvesting modelling for single house and society in Vadodara.</li> </ul>
References	
1	Barrow.C.J (2005), Environment Management and Development, Roulledge New York
2	Kumar.H.D (2001),Sustainable Human Ecology, East-West Press Pvt.Ltd
3	Krishnamoorthy . B. (2008), Environmental Management, Prentice-Hall of India Pvt. Ltd.
4	Chautervedi .P.(2003), Energy, Environment and Sustainable Development, Concept Publishing Company, New Delhi


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2020-2021
	M.Sc. Environmental Science : Regular Programme				
Year	I	Core ENV2105C05: PRACTICAL I - BIostatistics, COMPUTER APPLICATIONS AND INSTRUMENTATION TRAINING	Credits / Hours per week	03	
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100	
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Sampling process of Environmental Components				
2	Hypothesis testing				
3	Multivariate Analysis on collected environmental data- Z-test, F- test and ANOVA				
4	Computer-based modeling: Linear, regression, validation and forecasting.				
5	Computer-based modeling for population and population studies.				
6	Instrumentation Training on <ul style="list-style-type: none"> <li>• Gas chromatographic techniques</li> <li>• Titrimetric methods</li> <li>• Colorimetric methods</li> <li>• AA Spectrophotometric analysis</li> <li>• HPLC techniques</li> <li>• Ion exchange chromatography</li> <li>• Electrophoresis methods</li> <li>• PCR technique</li> <li>• Microscopy</li> </ul>				

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2106C06: PRACTICAL II - TOXICOLOGY AND WASTE ANALYSIS		Credits / Hours per week	03
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Toxicology				
2	Determine LD50/ LC50 values of toxicant exposure using plant and animal models.				
3	Aquatic toxicity testing using fish as model				
4	Sediment toxicity testing				
5	Biological sample processing for various chemical/pollutant analysis				
6	Study of histological features of plant and animal tissues under normal conditions and following exposure to toxicants				
7	Stomata density and opening/closing rate study following exposure to particulates and air pollutants.				
8	Industrial and municipal ecology, buffer zone and ecotoxicology				
9	Visit to nearby industrial areas and sites of pollution discharge and dumping to study the pollution impacts.				
10	Assess the probable threat and emergency preparedness towards natural disaster in schools and other educational institutes of Vadodara.				
11	Waste Management				
12	Sampling methods of solid waste				
13	Solid waste characterization: Analysis of Moisture content, Organic Matter, Organic Carbon, Sodium and Potassium, Nitrogen content, Potassium, Phosphorus				
14	Biological analysis of Municipal Solid waste: fungus, detritivore and decomposer animals				
15	Visit to solid waste dumping sites to study its disposal pattern and management				
16	Visit to medium and large hospital to understand their biomedical waste disposal and management.				


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2107C07: PRACTICAL III - ECOLOGY		Credits / Hours per week	03
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Collection and preservation techniques for microbes, fungi, plants and animals.				
2	Preparing biodiversity checklists, Frequency of occurrence, diversity and distribution pattern, abundance and density, Species richness, evenness and community dynamics.				
3	Sampling methods: random, adaptive, systematic, multistage and sequential				
4	Ecological census techniques: Different environs and different organisms: Quadrates and transects, point count, timed species count, pit fall technique, Vertical sampling in aquatic systems, grab sampling, etc.				
5	Biodiversity comparison of different communities, Biodiversity indices.				
6	Ecological evaluation of representative environmental resources: urban green belt, forest, stream, pond/lake, soil etc.				

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M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2108C08: FIELD VISIT TO ENVIRONMENTAL POLLUTION, WASTE DISPOSAL AND TREATMENT SITES		Credits / Hours per week	02
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Field work and discussion			
No.	Field Work				
1	The students will visit various sites of environmental pollution and waste disposal near Vadodara and different parts of Gujarat/India. The focus will be on to study the treatment processes for different types of industrial and municipal wastes.				


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2109C09: SEMINAR ON CURRENT ENVIRONMENTAL CHALLENGES AND TECHNOLOGY ADVANCES		Credits / Hours per week	01
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Seminar			
No.	Seminar Presentation				
1	On topics of current environmental challenges and technology advances and their applications in the study.				

		<b>The Maharaja Sayajirao University of Baroda</b> <b>Faculty of Science</b> <b>Department of Environmental Studies</b>	<b>Academic Year</b>	2020-2021
<b>M.Sc. Environmental Science: Higher Payment Programme</b>				
<b>Year</b>	I	<b>Core</b> ENV2201C01: NANOTECHNOLOGY, PLASMA SCIENCE AND BIOTECHNOLOGY	<b>Credits / Hours per week</b>	04
<b>Semester</b>	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	<b>Maximum Marks / Grade</b>	100
<b>Mode of Transaction</b>		Lecture, Tutorial and Assignments.		
<b>Unit No.</b>	<b>Topic/Unit</b>			
1	<b>Nanomaterials and Environmental applications</b> <ul style="list-style-type: none"> <li>• Types and properties of nanomaterials: TiO<sub>2</sub> nanoparticle, Iron based nanoparticle, bimetallic nanoparticles, Nanoparticulate photocatalysts and catalysts, Nanoclays, Nanotubes, Dendrimer &amp; nanosponges.</li> <li>• Self-assembled surfactants and Magnetic Nanoparticles</li> <li>• Nanomembrane and Nanosieve.</li> <li>• Advancement in nanomaterials and discovery of eco-centric technologies</li> <li>• Synthesis and environmental applications of nanomaterials</li> <li>• Health hazards of nanomaterials.</li> </ul>			
2	<b>Plasma Science and Environmental applications</b> <ul style="list-style-type: none"> <li>• Types and characteristics of plasma.</li> <li>• Plasma technologies: Plasma-catalytic reactors and Plasma arc technology</li> <li>• Treatment of air and water pollutants, solid and hazardous waste.</li> <li>• Methods of synthesis and environmental fate of plasma</li> <li>• Environmental impact of plasma applications.</li> </ul>			
3	<b>Microbial Biotechnology</b> <ul style="list-style-type: none"> <li>• Over view of microbiology of water, air and soil.</li> <li>• Biotechnological methods of environmental monitoring and pollution detection based on microbes, macromolecules and biosensors.</li> <li>• Microbial Reactors, genetically modified microbes &amp; their uses in Environmental management.</li> </ul>			


	<p><b>Genetic Engineering</b></p> <ul style="list-style-type: none"> <li>• Methods for measuring nucleic acid and protein interactions, Sequencing of nucleic acids</li> <li>• Polymerase Chain Reaction (PCR) and Nucleic acid hybridization (southern, northern, western blotting techniques).</li> <li>• Methodology of Introduction of desired genes into hosts like microorganisms, plants and animals, Molecular markers</li> <li>• Role of microbes in ecological and economic potentiation of waste.</li> <li>• Ecofriendly bio-products: Biopesticides, Biofertilizers, Biodegradable Plastics.</li> <li>• Biofuels: Source and production technology of alcohols &amp; biodiesel</li> <li>• Biotransformation, bioconversion, bioremediation, phytoremediation technology</li> </ul>
4	Assignments: The assignments are to reconsolidate fundamentals and therefore, are not given separate weightage for examination purpose.
Reference Books	
1	M. H. Fulekar, Bhawana Pathak, Environmental Nanotechnology, 1st Edition, 2017, CRC Press
2	Abdelaziz El Moussaouy, Environmental Nanotechnology and Education for Sustainability: Recent Progress and Perspective, Handbook of Environmental Materials Management, 2017
3	Du, Changming, Yan, Jianhua, Plasma Remediation Technology for Environmental Protection, Environmental Engineering and Physics, 2017
4	Sugiyama, L., T. Stix, and W. Mannheimer, Environmental Aspects in Plasma Science, 1997, AIP Press,

 <p>THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सत्यं शिवं सुन्दरम्</p>	<p>The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies</p>	<p>Academic Year</p>	<p>2020-2021</p>	
<p>M.Sc. Environmental Science: Higher Payment Programme</p>				
<p>Year</p>	<p>I</p>	<p>Core ENV2202C02: ECOLOGICAL ASSESSMENT AND CONSERVATION</p>	<p>Credits / Hours per week</p>	<p>04</p>
<p>Semester</p>	<p>II</p>	<p>Year of Introduction: 2020 Year of Syllabus Revision: NA</p>	<p>Maximum Marks / Grade</p>	<p>100</p>
<p>Mode of Transaction</p>		<p>Lecture, Tutorial and Assignments.</p>		
<p>Unit No.</p>	<p>Topic/Unit</p>			
<p>1</p>	<p><b>Ecological Assessment</b></p> <ul style="list-style-type: none"> <li>• Organismic populations: Single species population dynamics, Meta-populations and their spatial dynamics, Complexity with single and multiple trophic levels</li> <li>• Exploitative interactions, Interspecific interactions and multispecies coexistence,</li> <li>• Population demography, Carrying capacity</li> <li>• Field ecology techniques and community assessment: Habitat characterization, biodiversity quantification, Various assessment methods and indices</li> <li>• Landscape dynamics, Ecotone, edge effect, buffer zone and disturbance determination</li> <li>• Species vulnerability, Population viability analysis</li> <li>• Community interactions: Application of Lotka-Volterra model, Niche determination</li> <li>• Behavior and activity pattern of animals in natural habitat and in captivity</li> <li>• Threat assessment: Dependability for natural resources, Food resources exploitation, Anthropogenic pressure on terrestrial and aquatic habitats, Grazing pressure, Impacts of land use and land cover modifications, Impact of other stressors.</li> </ul> <p><b>Economic and Ecological Valuation of Biodiversity</b></p> <ul style="list-style-type: none"> <li>• Economic value of biodiversity: Use and non-use values, Access-Benefit sharing</li> <li>• Ecological value of biodiversity and ecosystem services</li> <li>• Valuation of corals and mangroves of India</li> </ul>			


2	<p><b>Conservation</b></p> <ul style="list-style-type: none"> <li>• Principles of conservation: Landscape to genetic levels</li> <li>• Evaluation of conservation priorities</li> <li>• Connectivity conservation approaches: Connectivity and meta-population dynamics in highly fragmented habitats, Corridors and buffer zones as connectivity components, Connectivity at the land-water interface, Connectivity in marine ecosystems, Assessment of ecological connectivity</li> <li>• Protected areas: Criteria and characteristics, Networks and Management of PA with Indian wildlife conservation examples</li> <li>• Conservation Projects in India</li> <li>• Captive breeding as successful ex-situ conservation approach</li> <li>• Climate Change Impacts on Biodiversity and Conservation, Global footprint of climate change</li> <li>• Restoration and Translocation as conservation approaches</li> <li>• Biodiversity Law, Legislation, Treaties and Policies: Biodiversity Conventions, Biodiversity Boards, Biodiversity Act, Wildlife Conservation Act, Wildlife Trade Act, etc.</li> </ul>
3	Carry out economic and ecological valuation of biodiversity of Faculty of Science, Residential colonies of the University and Bhukhi Stream passing through University, Different areas of Vadodara and surroundings.
References	
1	Chatterjee A.K. ( 2002) Introduction to Environmental Biotechnology, Prentice Hall of India Private Ltd,
2	B.R. & Pasternak J.J. (2003),Molecular biotechnology -Principles and application of recombinant DNA , ASM Press.
3	Ausubel F. M., Smith.J.A, Moore D.D, Brent R., Seidman J.G, (1999) Short Protocols in Molecular Biology,Wiley, John & Sons, Inc.
4	Anonymous (2007) The New Science of Metagenomics: Revealing the Secrets of Our Microbial Planet: Committee On Metagenomics: Challenges And Functional Applications; National Research Council, National Academies Press.
5	Dean J.R. (2007) Bioavailability, Bioaccessibility and Mobility of Environmental Contaminants: John Wiley & Sons, Ltd.


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science: Higher Payment Programme				
Year	I	Core ENV2203C03: AIR AND NOISE POLLUTION MONITORING AND MANAGEMENT	Credits / Hours per week	04
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	<p><b>Air Pollution</b></p> <ul style="list-style-type: none"> <li>• Fundamentals of Meteorology: Pressure, temperature, wind, humidity, radiation, atmospheric stability adiabatic diagrams, turbulence and diffusion. Scales of meteorology.</li> <li>• Applications of Meteorology: Applications of micrometeorology to vegetated surfaces, urban areas, human beings, animals. Application of meteorological principles to transport and diffusion of pollutants, atmospheric stability and plume behavior. Scavenging processes. Effects of meteorological parameters on pollutants and vice versa. Wind roses. Topographic effects.</li> <li>• Urban air pollution and its monitoring</li> <li>• Indoor air pollution and its monitoring</li> </ul>			
2	<p><b>Industrial Air Pollution</b></p> <ul style="list-style-type: none"> <li>• Industrial air pollution criteria and ambient air quality standards</li> <li>• Emission and transformation of industrial air pollutants</li> <li>• Dispersion of industrial air pollutants</li> <li>• Secondary acidification</li> <li>• Mining activity and associated particulate pollution</li> </ul>			


3	<p>Monitoring and Control Methods and Devices</p> <ul style="list-style-type: none"> <li>• Zoning atlas for siting industry</li> <li>• Air pollution control methods and devices</li> <li>• Control devices/equipment for particulates</li> <li>• Control devices/equipment for gaseous pollutants</li> <li>• Monitoring system for urban air pollution</li> <li>• Perspectives of sustainable air pollution management</li> <li>• Air (Control and Prevention of pollution) Act</li> </ul>
4	<p>Noise Pollution</p> <ul style="list-style-type: none"> <li>• Characteristics of sound wave</li> <li>• Sources and Impact on Human Health, measurement of Noise Level and Indices, Effect of meteorological parameters on noise propagation,</li> <li>• Acoustics- Loudness-sones and phons scale of loudness, Octave Bands, A- Weighted Decibels, Noise exposure levels and standards</li> <li>• Abatement and control of noise pollution</li> <li>• Noise Pollution (Regulation and Control) Rules</li> </ul>
5	<p>Assignment: Compile Meteorology, air pollution and noise pollution data for Vadodara and interpret the environmental status for past 10 years.</p>
References	
1	H.S. Peavy, D.R. Row & G. Tchobanoglous, Environmental Engineering, Mc Graw Hill International Edition
2	Anjaneyulu. Y, Air Pollution and Control Technologies”, Allied Publishers (P) Ltd., India 2002.
3	Aney E. R. 2007 water quality handbook. McGrawhill.
4	Fundamentals of Soil Behavior, Mitchell J.K and Soga K., John Wiley and Sons Inc. 2012.
5	Sharma B.K :(2001),Environmental Chemistry, GOEL Publishing House, Meerut(UP)
6	Mahandiyani V. (2006) Environmental Noise Pollution- causes, evils, legislations and controls. Deep and Deep Publications, New Delhi.


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science: Higher Payment Programme				
Year	I	Core ENV2204C04: WATER AND SOIL POLLUTION MONITORING AND MANAGEMENT	Credits / Hours per week	04
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	<p>Water Pollution:</p> <ul style="list-style-type: none"> <li>• Types and sources of water pollution.</li> <li>• Water pollution criteria and quality standards</li> <li>• Pollution status of major rivers and lakes of Gujarat and India</li> <li>• Drinking water quality standards</li> <li>• Ecological and Human Health hazards of water pollution</li> </ul>			
2	<p>Soil Pollution</p> <ul style="list-style-type: none"> <li>• Analysis of soil quality.</li> <li>• Industrial effluents and their interactions with soil components.</li> <li>• Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers</li> <li>• Hazards of soil pollution on agriculture produce vis a vis humans</li> </ul>			
3	<p>Characterization and Treatment of Wastewaters</p> <ul style="list-style-type: none"> <li>• Objectives of waste water treatment and water quality standards</li> <li>• Types of wastewater and their characteristics: Industrial: Chemical, Fishery processing, Food processing, Leather processing, Textile, dyeing and printing industry wastewater, Dairy industry wastewater, Soft drink bottling industry wastewater, Municipal wastewater,</li> </ul>			


	<p>Mining wastewater, Laboratory wastewater etc.</p> <ul style="list-style-type: none"> <li>• Design criteria and site selection for treatment plants, Importance of CETP</li> <li>• Low cost treatment systems for wastewater treatment.</li> <li>• Unit operations and processes in wastewater treatment</li> <li>• Physical treatment: Screening chambers, Grit chambers, sedimentation tank (design and functions), filtration (rapid and slow sand filters)</li> <li>• Chemical treatment: Chemical oxidation (hydrogen peroxide, ozone), coagulation and flocculation, disinfection using chlorine, ozone, UV, etc. Membrane filtration processes (RO, Ultrafiltration, nano-filtration) and adsorption</li> <li>• Biological treatments: attached and submerged, aerobic and anaerobic, Aerobic processes: Activated Sludge Process, Trickling Filters, Oxidation ponds and Rotating Biological Contactors. Anaerobic Processes: Up flow Anaerobic Sludge Blanket, Anaerobic digesters, anaerobic filters. Sludge handling treatment and disposal</li> </ul>
4	Review the qualitative status of village ponds within and surrounding Vadodara and their human health concerns
References	
1	Ramachandra.T.V (2006),Management of Municipal Solid Waste, Capital Publishing Company
2	Tchobanoglous G and Kreith. F(2002), Handbook of Solid Waste Management, Second Edition, McGraw-Companies.
3	Aarene Vesilind .P, Worrell.W & Reinhart.D(2002),Solid Waste Engineering, Cengage Learning India Pvt. Lt
4	Harry Freeman, Harry M. Freeman., Standard handbook of Hazardous waste treatment and disposal. Mc Graw Hill. (1998).
5	Porteous A. (1985) Hazardous waste management handbook. Butterworths, London(U.K)
6	Harish K.(2001) Environmental Health Hazards. Sarup& Sons, New Delhi.
7	Wentz C. A.(1995) Hazardous Waste Management ,Mc. Graw – Hill Book Company, Koga
8	Ministry of Environment & Forest: Guidelines for Transport, Storage and Disposal of Hazardous Waste. New Delhi.


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme				
Year	I	Core ENV2205C05: PRACTICAL - NANOTECHNOLOGY AND BIOTECHNOLOGY	Credits / Hours per week	03
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva		
No.	Experiment			
1	<ul style="list-style-type: none"> <li>• Synthesis of various metals and metal oxide nanoparticles, analysis of nanoparticles by UV-Vis spectrophotometer and application of nanoparticles on sorption, synthesis of TiO<sub>2</sub> nanoparticle and its application as a photocatalyst in water treatment, Study of chemical kinetics of Nano catalyst using UV spectroscopy.</li> <li>• Removal of pollutant by Iron Nanoparticles and/or bimetallic nanoparticles, Synthesis and characterization of colloidal suspension of nanoparticles, Environmental applications of dendrimer &amp; nanosponges, Toxic effect of nanoparticles on microbes.</li> <li>• Preparation of non-thermal plasma, characterization of plasma, environmental applications of non-thermal plasma, plasma catalysis, cleaning of contaminated surfaces by using plasma generated reactive species.</li> <li>• Assessment of bactericidal properties of low temperature plasma, disinfection and sterilization using plasma technology.</li> </ul>			
2	<ul style="list-style-type: none"> <li>• Microbial monitoring and analysis, Microbial growth kinetics, inhibitory growth kinetics and Microbial toxicity analysis.</li> <li>• Isolation and characterization of microorganisms for the biodegradation of pollutants. Enrichment culture techniques, and biodegradation kinetics</li> <li>• Analysis of protein, carbohydrate and nucleic acid and their extractions from biological samples.</li> <li>• Polymerase Chain Reaction and Gel Electrophoresis</li> </ul>			

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2020-2021
	M.Sc. Environmental Science : Regular Programme				
Year	I	Core ENV2206C06: PRACTICAL - ANALYSIS OF POLLUTION INDICATORS	Credits / Hours per week	03	
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100	
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Air Quality and Pollution Indicators				
2	Air pollution indicator (particulate and gaseous) analysis in industrial, urban residential and rural areas				
3	Auto – exhaust monitoring at different places in the city categorized on the basis of traffic during different time of the day				
4	Noise Pollution Monitoring studies				
5	Water Quality and Wastewater Pollution Indicators				


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2207C07: PRACTICAL – ECOLOGICAL ASSESSMENT AND CONSERVATION		Credits / Hours per week	03
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Field ecology techniques and community assessment: Habitat characterization, biodiversity quantification, Various assessment methods and indices				
2	Population demography, Carrying capacity				
3	Determine community structure and establish the abiotic and biotic correlations				
4	Habitat association, Niche measurement and resource preferences				
5	Wildlife census: Primary sighting, Camera trapping, Drone surveys. Secondary information like; pug marks, scat sampling, wildlife movement information, etc. Bird census, Mammal census				
6	Visit to zoo to study ex-situ conservation practices				
7	Behaviour of animals in natural habitat and in captivity				

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2208C08: FIELD VISIT TO BIODIVERSITY AND CONSERVATION SITES AND TO POLLUTION IMPACTED SITES		Credits / Hours per week	02
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Field work and discussion			
No.	Field Work				
1	The students will visit various sites of ecological importance, the ecological functions and processes therein. The students will learn various conservation practices employed to maintain the natural integrity of the habitats and conservation sites with or without impacts of environmental pollution.				


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2020-2021
M.Sc. Environmental Science : Regular Programme					
Year	I	Core ENV2209C09: SEMINAR PRESENTATION ON A RESEARCH ARTICLE		Credits / Hours per week	01
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Seminar			
No.	Seminar Presentation				
1	Seminar presentation on a research article encompassing the areas of environmental sciences and allied fields.				

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-22
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2301C01: REMOTE SENSING AND GIS APPLICATIONS	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	<b>Introduction to Remote Sensing and GIS</b> <ul style="list-style-type: none"> <li>Remote Sensing- concept and principle; Interaction of EMR with atmosphere and Earth's surface; Sensors-types, characteristic, and resolution; Platforms- types and their characteristics; Image Interpretation</li> <li>Definition and Components of GIS; Hardware and Software requirements for GIS; Coordinate system and projections; Data Structure and Format, Spatial Data Analysis; Open-Source software; Image Processing and GIS packages</li> <li>Concept of Global Positioning System; System segmentation; Classification of GPS receivers; Factors affecting GPS; Concept and principle of DGPS</li> </ul>			
2	<b>Advanced Technologies</b> <ul style="list-style-type: none"> <li>Thermal Remote Sensing: Thermal radiation principle and processes; Thermal properties of materials; Thermal sensors and scanners; Characteristics of thermal Image; Temperature mapping with thermal data; Multispectral thermal data</li> <li>Microwave Remote Sensing: Concept and Principle of microwave remote sensing; Passive and Active microwave sensors; RADAR, SLAR, synthetic real aperture radar system; SAR Interferometry</li> <li>LIDAR- concept, components and type; LIDAR derived vegetation and Urban information</li> </ul>			
3	<b>Application of Remote Sensing and GIS</b> <ul style="list-style-type: none"> <li>Forest Management: Interaction of EMR with vegetation; Spectral and temporal characteristics of the vegetation; Vegetation Indices; Forest cover mapping and change detection; LIDAR remote sensing for forest studies</li> <li>Water Resource Management: Spectral characteristics of water; drainage mapping and watershed management; flood mapping and zonation; Case studies of GIS application in surface water modelling; Application in Ground water management, artificial recharge</li> </ul>			


	<ul style="list-style-type: none"> <li>• Agriculture and Soil Management- Spectral properties of crops in optical and TIR region; crop identification and crop inventory; Soil mapping and conservation; Case studies of its application in drought management, damage assessment, land evaluation, and yield modelling</li> <li>• Urban Mapping and Management: Urban Sprawl; Change detection in Land use and Land Cover; Urban and regional planning; GIS application in Hazard risk and emergencies management.</li> </ul>
References	
1	Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, John Wiley.
2	Andy D. Ward and Stanley W. Trimble, 2004: Environmental Hydrology, second edition, Lewis Publishers.
3	Campbell, J.B., 2002: Introduction to Remote Sensing. Taylor Publications
4	Jensen J.R., 2007: Remote Sensing of the Environment: An Earth Resource Perspective, 2nd ed., Prentice Hall Panda,
5	B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited, India
6	Richards J.A. and Jia X., 2006: Remote Sensing Digital Image Analysis: An Introduction, 4th ed., Springer
7	DeMers, M.N., 1997: Fundamentals of geographic information system, Wiley, New York.

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-22
<b>M.Sc. Environmental Science: Higher Payment Programme</b>				
Year	II	Core ENV2302C02: IMPACT ASSESSMENT, AUDITING AND ENVIRONMENTAL ECONOMICS	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	Unit 1- EIA <ul style="list-style-type: none"> <li>• EIA NOTIFICATION 2006 GUIDELINES ,NABET</li> <li>• Procedure of Environmental Clearance</li> <li>• Environment Impact Assessment</li> <li>• Identify activities</li> <li>• Environment Impacts</li> <li>• Impact prediction</li> <li>• Methodologies</li> <li>• Assessment of Socio Economic Impacts</li> <li>• Reviewing of EIA and EMP Reports</li> </ul>			
2	Unit 2-EMS <ul style="list-style-type: none"> <li>• Introduction to Environmental Management System basic definitions and terms, Framework for Environmental Management Systems, Approach for developing an Environmental Management System.</li> <li>• The introduction and implementation of ISO 14001: environmental policy, planning, implementation and operation, checking, management review, etc.</li> <li>• Applications EMS in terms of Process flow chart, effluent Generation, composition and treatment of effluents from following industries – sugar, pulp and paper, electroplating, dairy, oil refineries, etc.</li> </ul>			
3	Unit 3-Env Auditing <ul style="list-style-type: none"> <li>• Introduction to Environmental Auditing, Category “A” &amp; “B” types of projects. Procedures and Guidelines to conduct Environmental</li> </ul>			


	<p>Audit.</p> <ul style="list-style-type: none"> <li>• Life cycle analysis; Concept of energy and green audit</li> <li>• Role of regulatory agencies and Pollution control boards</li> </ul>
4	<p>Unit 4-Env Economics</p> <ul style="list-style-type: none"> <li>• Introduction What is environmental economics; review of microeconomics and welfare economics.</li> <li>• The Theory of Externalities Pareto optimality and market failure in the presence of externalities; property rights and the coase theorem.</li> <li>• The Design and Implementation of Environmental Policy Overview; pigouvian taxes and effluent fees; tradable permits; choice between taxes and quotas under uncertainty; implementation of environmental policy.</li> <li>• International Environmental Problems Trans-boundary environmental problems; economics of climate change; trade and environment.</li> <li>• Measuring the Benefits of Environmental Improvements Non-Market values and measurement methods; risk assessment and perception.</li> </ul>
References	
1.	Barthwal R.R. (2002): Environmental Impact Assessment, New Age International (P)Ltd . Pub New Delhi.
2.	Agrawal S.K.(2002) Pollution Management- (Vol-3),A.P.H publishing
3.	Gabriele Crognale P.C (1999). Environmental management strategies (The 21 <sup>st</sup> century perspective) Printice Hall PTR
4.	Prabhakar V.K. (2001) Environmental Management. Anmol Publication pvt ltd.
5.	Kuhre W.L. (2000) ISO 14031 Environmental performance evaluation EPE,Prentice Hall, PTR.Upper Saddle River N.J.


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-22
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2303C03: INDUSTRIAL SAFETY, RISK ASSESSMENT AND DISASTER MANAGEMENT	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	<b>Industrial Safety</b> <ul style="list-style-type: none"> <li>Principles of Industrial Safety. Environmental regulations.</li> <li>Accidents, analysis of accidents, antidotes for chemicals. Emergency preparedness.</li> </ul>			
2	<b>Industrial Management</b> <ul style="list-style-type: none"> <li>Quality concepts and techniques used in industry. Elementary statistics and probability.</li> <li>Process control, Process capability and Quality Control tools.</li> <li>Functions and roles of all levels of management, organization design, and planning and control of manufacturing operations.</li> <li>Plant layout. Site selection and efficient arrangement of work areas to achieve lower manufacturing cost</li> </ul>			
3	<b>Risk Assessment</b> <ul style="list-style-type: none"> <li>Risk assessment – identification and quantification of various hazards that exist, (unsafe condition)</li> <li>Equipment and personnel exposed.</li> <li>Hazard and operability, Design and engineering,</li> <li>Risk to the neighboring marine and other components</li> <li>Failure probability, credible accident scenario, damage criteria,</li> <li>Worst case accident Scenarios, effect on population.</li> </ul>			


	<ul style="list-style-type: none"> <li>• Probity function analysis, Event Frequency Estimation.</li> </ul>
4	<p><b>Natural disaster management</b></p> <ul style="list-style-type: none"> <li>• Definition and explanation of terms: Disaster, accident, emergency, accident.</li> <li>• Classification of disasters</li> <li>• Disaster management cycle</li> <li>• Components of disaster management plan</li> <li>• Strategies for natural disaster mitigation for : Earthquake, , Mass movements, Floods, Drought, Forest fire, tropical cyclone</li> <li>• Disaster (Management) Act, 2005</li> </ul>
References	
1.	Hosetti, B.B. & Kumar, A. (1998): Environmental Impact Assessment & Management. Daya Pub. House, Delhi.
2.	Jain & Jain (2005) Environmental Law in India. Ascent Publication.
3.	Mehta, C.S. (1991): Environmental Protection & the Law. Ashish Pub., Delhi.
4.	Rajshekhar, C.V.(1992), Critical Issues in Environmental Management. (Global Environmental Series). Discovery Publication, Delhi.
5.	Rosencranz, A, Diwan,S. & Noble, M.L.(1995):Environmental Law & Policy in India.


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-22
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2304C04: ENVIRONMENTAL APPLICATIONS AND ENVIRONMENTAL LEGISLATION	Credits / Hours per week	04
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Lectures and Tutorials		
Unit No.	Topic/Unit			
1	Unit 1- National Env Laws <ul style="list-style-type: none"> <li>• "Environment Protection Act, 1986 –EIA – Infrastructure Projects &amp; Environment Introduction to Environment Tribunals</li> <li>• Chapter 5 – The National Green Tribunal Act, 2010</li> <li>• Chapter 5 – Introduction to Environmental Public Hearing (EPH) &amp; Processes</li> <li>• Chapter 6 – Introduction to displacement and rehabilitation</li> <li>• Chapter 7 – Displacement and Environmental Concerns"</li> <li>• The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and Forest Conservation Act, 1980 Chapter 5 – Panchayats Extension to Scheduled Areas (PESA) Act 1996 Chapter 6 – Wildlife Protection Act, 1972 Chapter 7 – Coastal Regulation Zone &amp; Coastal Regulation Management</li> </ul>			
2	<b>Unit 2- International Environmental Laws</b> Development of international environmental law, nature and scope of key international environmental law principles and rights (substantive and procedural) U.N. Conference on Human Environment, 1972 – Stockholm Principles, Establishment of Environmental Institutions like UNEP, World Charter for Nature, 1982; Ozone Protection – Montreal Protocol for the Protection of Ozone Layer, 1987 as amended; U.N. Conference on Environment and Development, 1992 – Rio Principles; U.N. Convention on Biological Diversity, 1992; Cartagena Protocol on Biosafety, 2000; U.N. Convention on Climate Change 1992, Kyoto Protocol, 1997; Forest Principles; Agenda 21; Human Right to Healthy Environment; Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, 1998 (Aarhus Convention); Johannesburg Conference, 2002; Rio+20-United Nations Conference on Sustainable Development, Paris Agreement, 2015			


3	Unit 3-Case studies Conservation of basic natural resources -water, air, soil
4	Unit 4- Case Studies Environmental problems -ecosystem threats, resource depletion, waste generation , economic disparities, landuse etc
References	
1.	Hosetti, B.B. & Kumar, A. (1998): Environmental Impact Assessment & Management. Dayal Pub. House, Delhi.
2.	Jain & Jain (1984): Environmental Law in India
3.	Mehta, C.S. (1991): Environmental Protection & the Law. Ashish Pub., Delhi.
4	Rajshekhar, C.V.(Ed.) (1992); Critical Issues in Environmental Management. (Global Environmental Series). Discovery Publication, Delhi.
5	Rosencranz, A, Diwan,S.& Noble, M.L.(1995):Environmental Law & Policy in India. Tripathi, Bombay


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2021-2022
M.Sc. Environmental Science : Regular Programme					
Year	II	Core ENV2305C05: PRACTICAL VII - RS AND GIS		Credits / Hours per week	03
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Introduction to QGIS and ArcGIS software				
2	Acquisition of remote sensing data from various portals				
3	Georeferencing of Toposheets				
4	Generation of Vector map, raster map				
5	Digital Elevation model and Contour generation				
6	Land use and Land cover classification				
7	Watershed delineation of a surface water-body				
8	Project work on a case study				


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2021-2022
M.Sc. Environmental Science : Regular Programme					
Year	II	Core ENV2306C06: PRACTICAL VIII - EIA CASE STUDIES, AWARENESS AND SOCIO-ECONOMIC STUDIES		Credits / Hours per week	03
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Study of EIA reports and EIS of developmental projects of chemical industry, Highway projects, Cement Industry, Port and Harbors. Study the Corporate Social Responsibility status of different industries. Study socio-economic impacts of the developmental projects. Prepare brochure and material for environmental awareness program and conduct such programs like mangrove plantation program				


	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies			Academic Year	2021-2022
M.Sc. Environmental Science : Regular Programme					
Year	II	Core ENV2307C07: PRACTICAL IX - INDUSTRIAL SAFETY, ENVIRON MONITORING AND MODELLING		Credits / Hours per week	03
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA		Maximum Marks / Grade	100
Mode of Transaction		Laboratory Experiments, field work, discussion and viva			
No.	Experiment				
1	Study Industrial Safety and Hazard Operations of different industries.				
2	Model the Hazard and Safety of hypothetical Industrial Unit				
3	Study and model the Hazard and Safety of Commercial and Educational Institutes				


		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2308C08: INDUSTRIAL/INSTITUTIONAL VISIT	Credits / Hours per week	01
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Project work/ Field Visit		

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies	Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2309C09: SEMINAR ON DISSERTATION PROPOSAL	Credits / Hours per week	02
Semester	I	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Project and Field Work		
Unit No.	Topic/Unit			
1	Seminar Presentation			

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2401C01: Pre Dissertation Seminar on Experimental Design and Methodology	Credits / Hours per week	02
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction	Data Collection, Data analysis and Presentation			

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2402C02: Dissertation Submission Assessment	Credits / Hours per week	04
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction	Project and Field Work			

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2403C03: Dissertation Presentation Assessment	Credits / Hours per week	06
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Project and Field Work		

	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Environmental Studies		Academic Year	2021-2022
M.Sc. Environmental Science: Higher Payment Programme				
Year	II	Core ENV2404C04: Comprehensive Viva Voce	Credits / Hours per week	04
Semester	II	Year of Introduction: 2020 Year of Syllabus Revision: NA	Maximum Marks / Grade	100
Mode of Transaction		Project work and Viva voce		

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