

**B.Sc. Environmental Science**  
**Proposed Syllabus to be implemented from**  
**AY 2023-24**  
**FS BSC I (Major/Minor)**

ID	Title	Credits
	<b>Major Courses</b>	<b>06</b>
ENV1101PT	<b>Fundamental of environmental science</b> <b>Unit 1: Introduction to environment</b> Definition, scope, types and components, importance of environmental science as a multidisciplinary subject, environmental education. Man environment interactions, human activities (urbanization, industrialization, agriculture) and their impacts on environment <b>Unit 2: Natural resources</b> Concept of resource, classification of natural resources (renewable and non – renewable) <b>Unit 3: Introduction to Ecology</b> Ecosystem and its types, food chain and food web, energy flow, habitat and niche, ecological pyramids Levels of organization - Population, community, ecosystem, biome	03
ENV1102PT	<b>Basics of environmental analytical techniques</b> <b>Unit 1: Sampling methods</b> Sampling methods of Air, Water and Soil <b>Unit 2: Basic instrumentation techniques</b> pH meter, EC meter, Nephelometer, Electronic weighing balance, shakers, centrifuge <b>Unit 3: Sterilization and aseptic conditions in Microbiology</b> Physical and chemical methods of sterilization, laminar flow hood	03
	<b>Minor 1 courses</b>	<b>06</b>
ENV1101MT	<b>Environmental chemistry</b> <b>Unit 1 Soil chemistry</b> Nature and composition of soil, Water and air in soil, Inorganic and Organic components in soil, Acid- Base and ion exchange reactions in soil <b>Unit 2 Water Chemistry</b> Properties of water, complexation and chelation, alkalinity and acidity, metal ions and calcium in water, Hydrate metal ions and acids, oxidation-reduction, pE-pH in water, Microbes in water,	02

	Occurrence and Importance of Chelating Agents in Water, Microbial Mediated Elemental Transitions And Cycles	
<b>ENV1102MT</b>	<p><b>Environmental physics</b></p> <p>Introduction to environmental physics: processes and issues  Earth's orbital parameters, Kepler's law of planetary motion, earth's gravity, magnetic fields and its thermal structure  Laws of thermodynamics, Gibb's free energy.  Energy transfer: Conduction, convection, radiation and evaporation.  Urban environment</p>	02
<b>ENV1103MT</b>	<p><b>Environmental Biology</b></p> <p><b>Unit 1 Animal world</b>  Outline of classification, animal adaptations (cursorial, fossorial, volant and arial) and behavioural responses to various stimuli, adaptations for aquatic life (marine and freshwater)</p> <p><b>Unit 2 Plant world</b>  Outline of classification, types of plant tissues (simple and complex), Physiology and biochemistry of plants  Adaptions (Anatomical, morphological and physiological) to abiotic factors</p>	02
	<b>Minor 2 courses</b>	<b>06</b>
<b>ENV1101MTL</b>	<p><b>Basics of Environmental analysis – Laboratory –P</b></p> <p>Good laboratory practices.  Storage and maintenance of samples  Preparation of normal, molar, molal, ppm, percentage solutions and buffers.  Sampling of air, water and soil  Soil texture, moisture, colour, bulk density, water holding capacity</p>	04
<b>ENV1104MT</b>	<p><b>Basics of Environmental monitoring – Field Work</b></p> <p>Field surveys and on-site monitoring  Sampling and Analysis of pH, EC, TDS, Temperature in water and soil samples  Sampling and Analysis of DO, BOD and COD of water samples  Analysis of free CO<sub>2</sub>, Chloride, Hardness (Ca, Mg and Total), acidity, alkalinity, oil and grease</p>	02
	<b>VAC</b>	<b>02</b>
<b>ENV1101VC</b>	<b>Environment and Sustainability</b>	02

	Indicators of sustainable development, Changing fashion and its impact on environment. Sustainable solutions and future perspective. Sustainable food systems and agriculture. Sustainable practices. Concept of circular economy. Concept of ecological footprint, HDI and SDI.	
	<b>AEC</b>	<b>02</b>
<b>ENV1102SE</b>	<p><b>Communication skill – P</b></p> <p><b>Unit 1: Basics of effective communication</b> Components of communication, empathy, persuasion, perception and listening, writing, speaking and voice modulation, audience analysis, group discussion and oration.</p> <p><b>Unit 2: Environmental communication</b> Public involvement and awareness and its importance Role of media in conservation of natural resources, dissemination of information in ecology and in mitigating environmental problems, Communicating Risk &amp; Uncertainty, Environmental Journalism</p>	02
	<b>Total</b>	<b>22</b>

### SS BSC I (Major/Minor)

<b>ID</b>	<b>Title</b>	<b>Credits</b>
	<b>Major</b>	<b>06</b>
<b>ENV1201PT</b>	<p><b>Natural resources management</b></p> <p><b>Unit 1 Essential resources and their management</b> Global and national status Concept of sustainable natural resource management Management of water resources and integrated water resource development and management Sustainable soil/land and agriculture management Mineral resources, extraction and management Biodiversity as natural resource and its conservation Integrated Forest management</p> <p><b>Unit 2 Renewable energy resources</b> Global and national status, Harnessing energy from renewable resources, Tidal, wave, wind, solar, hydropower, geothermal, biomass (techniques and applications)</p>	03


ENV1201PT	<p><b>Fundamentals of ecology</b></p> <p><b>Unit 1 Structure and functions of ecosystems</b>  Abiotic factors and organisms – Liebig’s law of minimum, Shelford’s law of tolerance, ecological amplitude  Bio-geochemical cycles (hydrological, Carbon, Nitrogen, Phosphorous, Sulphur)  Ecological successions (Hydrosere, Xerosere)  Resilience and stability of ecosystems</p> <p><b>Unit 2 Population ecology</b>  Single species dynamics and dispersal, growth and survival, growth models, concept of metapopulations, r and K selection</p> <p><b>Unit 3 Community ecology</b>  Community interaction (Mutualism, Amensalism, Comensalism, Parasitism, Predation, Herbivory, Antagonism, Proto-cooperation, Neutralism) and outcomes viz. character displacement, resource partitioning, competitive exclusion</p>	03
	<b>Minor 1</b>	<b>06</b>
ENV1201MT	<p><b>Environmental data management</b></p> <p>Types of data, data inputs, data sorting and segregation, data handling and management.  Sources of different types of data: sources of various types of environmental data and means of acquisition  Data analysis (measures of central tendency and dispersal) and representation</p>	02
ENV1202MT	<p><b>Earth science</b></p> <p><b>Unit 1 :</b> Earth’s interior and geological processes, Geological processes and environment, types of rocks (igneous, metamorphic and sedimentary), rock cycle, continental drift theory  <b>Unit 2:</b> Geological formations of ground water, basic concept of geomorphology, River basin and drainage network, types of drainage patterns, stream ordering</p>	02
ENV1203MT	<p><b>Atmospheric science</b></p> <p><b>Unit 1:</b> Evolution of earth’s atmosphere, its structure and composition; Atmospheric variables with space and time: temperature, pressure, winds (types of winds – local, seasonal, global), Atmospheric stability and temperature inversion  <b>Unit 2:</b> global air circulation model, humidity (means of expression and measurement), evaporation, forms of condensation precipitation and sublimation, cloud formation, types of clouds</p>	02
	<b>Minor 2</b>	<b>06</b>

<b>ENV1201MTL</b>	<b>Field ecology techniques – P</b> Vegetation survey and census: collection of data for individual tree species (height, DBH, location) Animal survey and census: Birds: point count, transects, direct count; Invertebrates: quadrat sampling, belt transects, pit fall sampling for terrestrial insects; Plankton: grab sampling Species accumulation curves and rarefaction curves, calculation of Diversity indices	04
<b>ENV1204MT</b>	<b>Green environment</b> <b>Introduction:</b> Basic principles of green technology, green energy, green chemistry, green economy, green building, green nano-technology <b>Role of green technologies towards sustainable future:</b> energy efficiency, zero waste technologies, pollution abatement technologies, Clean Development Mechanisms, conservation of natural resources, green alternatives	02
	<b>VAC</b>	<b>02</b>
<b>ENV1201VC</b>	<b>Fundamental of Climate Change</b> <b>Unit 1:</b> Introduction to Climate Change, Anthropogenic Drivers of Climate Change, Observed Trends and Impacts of Climate Change, <b>Unit 2:</b> Climate Change Adaptation, International agreements, Intergovernmental panel on Climate Change	02
	<b>AEC</b>	<b>02</b>
<b>ENV1202SE</b>	<b>Environmental data management – P</b> Understanding various sources of environmental data; spatial, attribute, qualitative, quantitative ENVIS, CPCB, SPCBs, Census of India, Survey of India, Ground water boards, BHUVAN etc. Data input in MS excel, Data sorting and segregation, handling and management techniques. Data analysis tool pack. Representation of data using graphs and charts.	02
	<b>Total</b>	<b>22</b>

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**SS BSC II**

Paper Code	Paper Name	Components (Credit)		Total Credit
		Theory	Practical	
<b>Major</b>		<b>Theory</b>	<b>Practical</b>	<b>12</b>
ENV1401PT	Environmental Biotechnology and Microbiology	3	1	4
ENV1402PT	Remote Sensing and GIS	3	1	4
ENV1401MT	Liquid and solid waste management	3	1	4
<b>Multi-disciplinary</b>				<b>4</b>
ENV1401MDC	Disaster management	4	0	4
<b>SEC: Skill Enhancement Course</b>				<b>2</b>
ENV1401SEC	Environmental Advocacy and awareness	0	2	2
<b>AEC: Ability Enhancement Course</b>				<b>2</b>
ENV1401AEC		2	0	2
<b>VAC: Value Added Course</b>				<b>2</b>
ENV1401VAC	Ecotourism	2	0	2
<b>Total</b>				<b>22</b>


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	B.Sc. (Hons. with Research) Environmental Science: HPP				
YEAR	II	<b>Major: Principal Theory and Practical</b> <b>ENV1401PT: Environmental Biotechnology and Microbiology</b>		CREDIT	4
Semester	II			HOURS	75
OBJECTIVES:		1. To introduce microbial diversity and adaptations of microorganisms to various environmental conditions. 2. To acquaint the students with latest biotechnological practices. 3. To equip the students with practical microbiological tools and techniques			
<b>COURSE CONTENT / SYLLABUS</b>					

<b>UNIT-I</b>	<b>Microorganisms in the Environment</b>	15 hrs.
	<ul style="list-style-type: none"> <li>- Microbial evolution and diversity and Historical perspective</li> <li>-Range of conditions that support life and how microorganisms are adapted to that, Ecological groups based on requirement of oxygen, carbon, temperature and nutrition; Extremophiles</li> <li>-Aero Microbiology - Indoor aero microbiology, aero microbiology of pharmacy hospitals, storage materials (library, wall paintings) aero allergens, phylloplane micro flora, microbial interactions on leaf surface</li> </ul>	
<b>UNIT-II</b>	<b>Microbial Growth and applied aspects</b>	15 hrs.
	<ul style="list-style-type: none"> <li>-Culture and media preparation – solid and liquid. Types of media – semi synthetic, synthetic, enrichment, selective and differential media. Pure culture techniques – serial dilution, pour, spread, streak plate. Anaerobic cultivation of bacteria. Growth Curve, Diauxie</li> <li>-Microbial diseases human beings: Air-borne, food-borne, water borne</li> <li>-Importance of microorganisms for agriculture</li> </ul>	
<b>UNIT-III</b>	<b>Introduction to Environmental Biotechnology</b>	15 hrs.
	<ul style="list-style-type: none"> <li>-Extraction and Purification of nucleic acids, Detection and Quantitation of Nucleic acids, Gel Electrophoresis.</li> <li>-Restriction Endonucleases, Ligation, Alkaline Phosphatases, Ways of joining DNA Molecules. Methods of Delivering engineered DNA into selected host organism.</li> <li>-PCR: basic features and application, Principle and applications of Nucleic acid hybridization</li> </ul>	
<b>UNIT-IV</b>	<b>Practical</b>	30 hrs
	<ul style="list-style-type: none"> <li>- Bacteriological examination of environmental samples.</li> <li>Culture and media preparation – solid and liquid. Types of media – semi synthetic, synthetic, enrichment, selective and differential media.</li> <li>-Pure culture techniques – serial dilution, pour, spread, streak plate.</li> <li>-Enumeration of heterotrophic bacterial count and morphology studies from environmental samples.</li> <li>-Biotechnological tools for the microbial monitoring –PCR, Gel electrophoresis</li> <li>-Microbial growth curve using turbidometric measurement of bacterial growth</li> <li>-Isolation, Observation of Rhizobium from root nodules.</li> </ul>	
<b>REFERENCES</b>		
1.	Ananthanarayan and Paniker's Textbook of Microbiology, Twelfth Edition, Universities Press (India) Pvt. Ltd.	
2.	Michael Pelczar, Microbiology, 5 <sup>th</sup> Edition, McGraw Hill Education	
3.	R. M. Atlas, 2 <sup>nd</sup> Edition, Principles Of Microbiology, Mosby Publishers	

4.	TA Brown (2010) Gene Cloning and DNA Analysis: An Introduction, Wiley; 6th edition
5.	Sandy B. Primrose, Richard Twyman (2006) Principles of Gene Manipulation and Genomics, 7th Edition Wiley-Blackwell

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<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>					
YEAR	II	<b>Major: Principal Theory and Practical  ENV1402PT: Remote Sensing and GIS</b>		CREDIT	4
Semester	II			HOURS	75
<b>OBJECTIVES</b> :		1. To introduce basics of remotes sensing and GIS to students 2. To introduce the open source GIS software for data management			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>	<b>Basics of Remote Sensing</b>				15 hrs.
	<ul style="list-style-type: none"> <li>• Remote Sensing- concept and principle;</li> <li>• Interaction of EMR with atmosphere and Earth's surface;</li> <li>• Sensors-types, characteristic, and resolution;</li> <li>• Platforms- types and their characteristics;</li> <li>• Image Interpretation</li> </ul>				
<b>UNIT-II</b>	<b>GIS and GPS</b>				15 hrs.
	<ul style="list-style-type: none"> <li>• Definition and Components of GIS; Hardware and Software requirements for GIS;</li> <li>• Coordinate system and projections;</li> <li>• 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>				
<b>UNIT-III</b>	<b>Application of Remote Sensing and GIS</b>				15 hrs.
	<ul style="list-style-type: none"> <li>• Forest Management</li> <li>• Water Resource Management</li> <li>• Agriculture and Soil Management</li> <li>• Urban Mapping and Management</li> </ul>				
<b>UNIT-IV</b>	<b>Practical</b>				30 hrs
	a) Introduction to open-source GIS software b) Remote Sensing data products and their procurement c) Spatial Data analysis- vector and raster-based data analysis d) Georeferencing e) Map Digitization and layer creation f) Data Input, data editing, linking spatial and non-spatial data.				


	g) Overlay Analysis, Buffer analysis and quarry analysis (selection by location and attributes)	
	h) Output Map generation	
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.	

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	B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)			
YEAR	II	<b>Minor: Theory</b> <b>ENV1401MT : Liquid and Solid waste management</b>	CREDIT	4
Semester	II		HOURS	75
OBJECTIVES :	4. To inculcate the concepts and knowledge and concepts of solid waste including Hazardous waste and E-waste, and their management. 5. To elevate the students understanding about the concepts of hazard, vulnerability and risk during Handling. 6. To develop understanding about the practical approaches of Integrated waste management.			
<b>COURSE CONTENT / SYLLABUS</b>				
<b>Unit – I</b>	<b>Solid waste management</b>			15 hrs.
	Treatment and Disposal of Municipal Solid Waste: –composting, vermin-composting, autoclaving, microwaving, incineration, non-incineration thermal techniques, use of refuse derived fuels, landfilling. Treatment and Disposal of Hazardous Waste. Municipal and Hazardous Management in India. Definition, sources, categories of Biomedical waste as per the legislation. Segregation, transportation, Treatment and disposal methods. Bio-Medical Waste (Management and Handling) (Amendment) Rules,2003. E waste & Battery Waste Management: Sources, effects, segregation, recycling treatment and disposal Batteries (Management and Handling), Amendments Rules, 2010. E-waste (Management and Handling) Rules 2011			

<b>Unit – II</b>	<b>Integrated waste management</b>	15 hrs.
	Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management. Cradle-to-grave approach; lifecycle inventory of solid waste; role of life cycle assessment (LCA) in waste management; advantage and limitation of LCA; case study on LCA of a product.	
<b>Unit – III</b>	<b>Water treatment</b>	15 hrs.
	a) Objectives of water treatment systems	
	b) Water treatment plants and units – coagulation & flocculation, sedimentation, filtration, adsorption and disinfection	
<b>Unit-IV</b>	c) Water treatment technologies for domestic, recreation and industrial uses.	30 hrs
	<b>Practical</b>	
	<ul style="list-style-type: none"> <li>• Waste processing technologies Mechanical treatment and resource recovery.</li> <li>• Types of material recovery facilities;</li> <li>• Thermal treatment of solid waste: incineration, pyrolysis, gasification, residues and its utilization,</li> <li>• Biological treatment: Composting, bio-methanation, bio-gas, bio-diesel</li> </ul>	

#### REFERENCES

1.	Keller Bhatia H. S. (2003). A Textbook on Environmental Pollution and Control. Galgotia Publications Private Limited, Delhi.
2.	Hester RE and Harrison RM (2002) Environment and health impact of solid waste management activities, RSC.
3.	Arceivala JS and Hasolekar RS (2008) Waste-water treatment for pollution control and reuse, 3rd Ed. TMH.
4.	Liu David, Ed (1999) Environmental Engineers Handbook, CRC Press
5.	Morris Peter and R Therivel (2009) Methods of environmental
6.	Aney E. R. 2007 water quality handbook. McGrawhill.

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	B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)			
YEAR	II	<b>Multi-Disciplinary Course: Theory</b> <b>ENV1401MDC : Disaster Management</b>	CREDIT	4
Semester	II		HOURS	60

<b>OBJECTIVES</b> :	<p>7. To inculcate the concepts and knowledge and concepts of disasters, accidents and their management.</p> <p>8. To elevate the students understanding about the concepts of hazard, vulnerability and risk.</p> <p>9. To develop understanding about the practical approaches of disaster management at various levels of organization.</p> <p>10. To elevate the level of disaster preparedness through academic teaching learning activities.</p>
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**COURSE CONTENT / SYLLABUS**


<b>Unit – I</b>	<b>Fundamentals of Disasters</b>	30 hrs.
	<p>Concept of hazard, vulnerability, risk, accident and disaster            Classification of hazards and disasters: Natural and Human induced            Causes and impacts of disasters:            Natural disasters: Earthquake, Tsunami, Flood, Mass movement (landslides, mud flow, rock fall, avalanches, surface creep), Glacial Lake Outburst Flood (GLOF) &amp; Landslide Lake Outburst Flood (LLOF), Forest fires, Biological disasters.            Man – induced disasters: Transportation, Dam failure, nuclear and radiological, war, civil unrest, environmental pollution etc.            Disasters, ecosystem and economy.            Variability in Disaster Risk and Vulnerability profile on spatio-temporal scale.            Assessment of Risk, Vulnerability using Remote Sensing and GIS technologies.</p>	
<b>Unit – II</b>	<b>Disaster Management and Mitigation strategies, legislation and organizations</b>	30 hrs.
	<p>Disaster Management Cycle: Prevention, mitigation, preparedness, rescue, relief, reconstruction and rehabilitation.            Approaches for Disaster Risk Reduction (DRR): structural and non-structural measures for Earthquake, Tsunami, Flood, Mass movement (landslides, mud flow, rock fall, avalanches, surface creep), Forest fires            Awareness and Education programmes            Concept of Community Based Disaster Management (CBDM)            Disaster, insurance and compensation            Disaster Management Act, 2005            Institutional Framework for Disaster Management in India: NDMA, SDMA, DDMA, NIDM, NDRF, Budgetary provisions            International framework for Disaster Risk Reduction: Hyogo Framework, Sendai Framework, United Nations International Strategy for Disaster Reduction.</p>	


**REFERENCES**

7.	Keller, E. A. (2007). Introduction to environmental geology. Prentice-Hall, Inc.
8.	Botkin, D. B., & Keller, E. A. (1998). Environmental science: earth as a living planet (No. Ed. 2). John Wiley & Sons Ltd.
9.	Valdiya, K. S. (2004). Geology, Environment, and Society. Universities Press.
10.	Singh, R. (2017), "Disaster Management Guidelines for Earthquakes, Landslides, Avalanches and Tsunami" Horizon Press Publications
11.	Taimpo (2016). Disaster Management and Preparedness" CRC Press Publications
12.	Nidhi, G. D. (2014), "Disaster Management Preparedness" CBS Publications Pvt. Ltd.
13.	Gupta A.K. Nair, SS. Shiraz, A. and Dey, S. (2013), "Flood Disaster Risk Management, CBS Publications Pvt. Ltd

14.	Singh R. (2016). "Disaster Management Guidelines for Natural Disasters Oxford University Press Pvt. Ltd
15.	Gazette of India and amendments.

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<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>					
YEAR	II	<b>SEC: Skill Enhancement- Practical</b> <b>ENV1401SEC: Environmental Advocacy and Awareness</b>		CREDIT	2
Semester	I			HOURS	60
<b>OBJECTIVES:</b>		1. To introduce the concept of environment advocacy and activism. 2. To encourage youth participation in environment conservation. 3. To inculcate the strategizing and development of environmental awareness.			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>		<b>Basics of Environment Conservation and Activism</b>			30 hrs.
		<ul style="list-style-type: none"> <li>• To identify, evaluate and scientifically report local environmental issues and problems.</li> <li>• To carry out Social surveys to assess peoples' perception about various environmental issues, problems as well as their probable solutions.</li> <li>• To employ suitable methods for improved peoples' participation for environmental conservation.</li> </ul>			
<b>UNIT-II</b>		<b>Environment Awareness</b>			30 hrs.
		<ul style="list-style-type: none"> <li>• Strategizing environment awareness for selected target groups as per their attributes viz., socio-economic class, educational status etc.</li> <li>• To conduct drama, skit, public speaking, mass communication (use of social and print media) for environmental awareness.</li> <li>• Case studies and examples to emphasize the importance of awareness.</li> </ul>			
<b>REFERENCES</b>					
1.	How much should a person consume? Thinking through the environment. – Ramchandra Guha, 2006				
2.	Environmental issues of India. – Mahesh Rangarajan, 2007				
3.	Environment Awareness in The Hills - Dr. Surojit Sen Gupta, 2018				

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<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>					
YEAR	II	<b>AEC: Ability Enhancement Course: Theory</b> <b>ENV1401 AEC:</b>		CREDIT	2
Semester	I			HOURS	30
<b>OBJECTIVES:</b>		1. To develop the verbal and written communication skills of students. 2. Articulation and voice modulation for better emphasis during audio-video presentation.			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>	<b>Faculty</b>				15 hrs.
<b>UNIT-II</b>					15 hrs.
	Faculty				
<b>REFERENCES</b>					
1.					
2.					

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<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>					
YEAR	II	<b>Value Added Course: Theory</b> <b>ENV1401VAC: Ecotourism</b>		CREDIT	2
Semester	I			HOURS	30
<b>OBJECTIVES:</b>		1. Understand and comprehend the theories and practices of ecotourism. 2. Use the theoretical knowledge to manage ecotourism resources. 3. Understanding difference between sustainable tourism and mass tourism. To study case studies of eco-tourism projects			
<b>UNIT-I</b>	<b>Fundamentals of Ecotourism</b>				15 hrs.
	Ecotourism- Evolution, Principles, Trends and Functions of Ecotourism -Mass Tourism Vs Ecotourism Typology of Eco-tourists - Ecotourism Activities & Impacts;				

	Qubec Declaration 2002 - Kyoto Protocol 1997 - Oslo Declaration 2007. Ecotourism Development - Sustainable Ecotourism - Resource Management - Socio-economic Development	
<b>UNIT-II</b>	<b>Ecotourism Conservation and Case studies</b>	15 hrs.
	Conservation of Ecotourism - Protected Area Management through Ecotourism Stakeholder Engagement - Community Participation - Types of Participation, Issues and Challenges Ecotourism Projects -Case Studies on Sunderban Ecotourism Project, Kaziranga National Park, Run of Kutch, Nandadevi Biosphere Reserve, Corbett National Park, Gulf of Mannar, Kruger National Park, Ecotourism Development Agencies- Role of the International Ecotourism Society - the UNWTO, UNDP, WWF - Department of Forest and Environment - Government of India, ATREE, EQUATIONS.	
1.	<b>Weaver, D. (2001)</b> , THE ENCYCLOPEDIA OF ECOTOURISM, <i>CABI Publication</i> .	
2.	<b>Sukanta K Chaudhury</b> , CULTURAL, ECOLOGY AND SUSTAINABLE DEVELOPMENT, <i>Mittal, Delhi</i> .	
3.	<b>Ralf Buckley (2004)</b> , ENVIRONMENT IMPACTS OF ECOTOURISM, <i>CABI, London</i>	

**B.Sc. Environmental Science**  
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**AY 2025-2026**

**FS BSC III**

Paper Code	Paper Name	Components (Credit)		Total Credit
		Theory	Practical	
<b>Major</b>				
<b>ENV1501PT</b>	Environmental Pollution Management -I	3	1	4
<b>ENV1502PT</b>	Analytical Techniques & Instrumentation	3	1	4
<b>ENV1503PT</b>	Environmental Health & Safety Aspects	3	1	4
<b>Electives (Any 2)</b>				<b>8</b>
<b>Elective 1</b>	Environmental Microbiology	3	1	4
<b>Elective 2</b>	Environmental Biotechnology	3	1	4
<b>Elective 3</b>	Environmental Economics	4	0	4

<b>SEC: Skill Enhancement Course</b>				<b>2</b>
<b>ENV1501 SEC</b>	<b>Research Methodology and Environmental Statistics</b>	1	1	2
<b>Total</b>				<b>22</b>

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	B.Sc. (Hons. with Research) Environmental Science: HPP			

YEAR	III	<b>Major: Principal Theory and Practical</b> <b>ENV1501PT: Environmental Pollution Management -I</b>	CREDIT	4
Semester	I		HOURS	75

OBJECTIVES:	To understand air, soil, and noise pollution management techniques and strategies to reduce the pollution.
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**COURSE CONTENT / SYLLABUS**

<b>UNIT-I</b>	<b>Management of Air Pollution</b>	15 hrs.
	Stack sampling (with special emphasis on isokinetic sampling) and analysis of temperature, flow velocity, composition. Green belt design. Control of air pollution by process change Technology for gaseous air pollution Control: SO <sub>x</sub> , NO <sub>x</sub> , Vehicular pollution and urban air quality management. Carbon monoxide, Carbon dioxide control, Hydrocarbon and VOC Control, General method for controlling particulate matter, Prevention of exposure to indoor air contaminants.	
<b>UNIT-II</b>	<b>Soil Pollution Management Techniques</b>	15 hrs.
	In-situ techniques: Chemical Oxidation, Electrokinetic Remediation, Bioremediation, Phytoremediation, and Natural Attenuation. Ex-situ techniques: Excavation and Disposal, Soil Washing, Stabilization and Solidification, Thermal Treatment, biological treatment Emerging technologies: Nanotechnology, , Combined and Hybrid Techniques. Case studies on successful remediation projects.	
<b>UNIT-III</b>	<b>Noise pollution management</b>	15 hrs.
	-Noise related Fundamental definitions (Amplitude, Frequency, and Sound Intensity Level; Hearing mechanism and damages due to noise; Noise mapping, Control and Mitigation; Absorption and Blocking Noise; Noise Measurement devices	
<b>UNIT-IV</b>	<b>Soil Analysis and Monitoring of Noise Pollution -Practical</b>	30 hrs
	-Soil collection from different locations and testing for heavy metals concentration byAAS Preparation of saturation p a s t e extract, measurement of pH, EC, CO <sub>3</sub> <sup>2-</sup> , HCO <sub>3</sub> <sup>-</sup> , Ca, Mg, K and Na, Chemical analysis of soil for total and available nutrients (major and micro) -Evaluate the environmental and health risks of soil contamination. -Noise pollution monitoring studies	

	-Noise Dosimeters for occupational noise assessments	
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REFERENCES

1.	Shankar, S., & Shikha. (2017). Management and remediation of problem soils, solid waste and soil pollution. Principles and applications of environmental biotechnology for a sustainable future, 143-171.
2.	Duarte, A. C., Cachada, A., & Rocha-Santos, T. A. (Eds.). (2017). Soil pollution: from monitoring to remediation. Academic Press.
3.	Fullen, M. A., & Catt, J. A. (2014). Soil management: problems and solutions. Routledge.

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B.Sc. (Hons. with Research) Environmental Science: HPP

YEAR	III	<b>Major: Principal Theory and Practical</b> <b>ENV1502PT: Analytical Techniques &amp; Instrumentation</b>	CREDIT	4
Semester	I		HOURS	75


OBJECTIVES:	<ol style="list-style-type: none"> <li>To understand the fundamentals of various tools and techniques</li> <li>To study the application of techniques for analysis of environmental related sample</li> </ol>
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COURSE CONTENT / SYLLABUS


<b>UNIT-I</b>	<b>Microscopy and Electrophoresis</b>	15 hrs.
	Fluorescence, Confocal and Electron (Scanning and Transmission) Microscopy; Principle and applications: Native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, and Agarose gel electrophoresis.	
<b>UNIT-II</b>	<b>Spectroscopy</b>	15 hrs.
	Principle of UV-Vis and IR Spectroscopy and their applications; Flame photometer, Atomic Absorption Spectroscopy; Atomic emission spectroscopy, Inductively Coupled Plasma; Mass Spectroscopy	
<b>UNIT-III</b>	<b>Chromatography</b>	15 hrs.
	Principles and applications: Paper, Thin layer, Gel Chromatography, HPLC, Ion exchange and Affinity Chromatography, Gas Chromatography	
<b>UNIT-IV</b>	<b>Practical Training on Analytical Techniques</b>	30 hrs
	Sample preparation of the various techniques: Microscopy (use of a microscope to examine plant cells) and chromatography (Separation of dissolved organic compounds by using Paper, TLC and Gas Chromatography) Spectrophotometric analysis (Preparation of calibration curve and identified $\lambda$ Max)	

REFERENCES


1.	De, A.K. Environmental Chemistry. New Age International pvt. ltd, New Delhi
2.	Southworth, H.M. Introduction to Modern Microscopy
3.	Willard, H.H., Meritt, L.L., Dean, J.A. and Settle, F.A. Instrumental Methods of Analysis.
4.	Wilson K and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

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	B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)			
YEAR	III	<b>Major: Principal Theory and Practical</b> <b>ENV1503PT : Environmental Health &amp; Safety Aspects</b>	CREDIT	4
Semester	I		HOURS	75
OBJECTIVES :	To give knowledge about occupational health, industrial hygiene, accidental prevention techniques to the students.			
<b>COURSE CONTENT / SYLLABUS</b>				
<b>Unit – I</b>	<b>Environmental Health and Toxicology</b>			15 hrs.
	Understanding linkages between Environment and Public Health, Occupational Health, Environmental Epidemiology, Bio-Terrorism Principles of Toxicology: Characteristics of Exposure and Dose-response relationship, Toxic effects of Metals, Pesticides, Solvent & Vapors, Responses of respiratory, renal and hepatic systems in toxicological manifestations: Indicator parameters.			
<b>Unit – II</b>	<b>Occupational &amp; Industrial Health Hazards</b>			15 hrs.
	Concept of health and occupational health, Spectrum of health, Occupational and work-related diseases; Levels of prevention, History of occupational health, Characteristics of occupational diseases, Essentials of occupational health service, personal protective equipments for head, ear, face, eye, foot, knee and body protection, Respiratory personal protective devices. The concept of industrial safety, health and environment - need, nature and importance. Focus on Human resource, and concept of importance of ‘man’ as central theme in safety. Concept of accident prevention, occupational health and environmental protection. Problems of Industrial safety, occupational health and environmental pollution & modern concept of Safety Health and Environment (SHE)			
<b>Unit – III</b>	<b>Industrial Safety and Risk Assessment</b>			15 hrs.
	Safety legislation: Acts and rules, Safety standards and codes, Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, Safety policy: safety organization and responsibilities and authorities of different levels. ILO Convention and Recommendations in the furtherance of safety, health and welfare. Vocational prospects in Industrial Safety, Indian Legislation on Industrial Safety; Accidents, analysis of accidents, antidotes for chemicals. Emergency preparedness Risk assessment – identification (HAZID) and quantification of various hazards that exist, Risk Analysis Techniques <ul style="list-style-type: none"> <li>• Vulnerability Analysis: Toxic, Explosion, Fire</li> <li>• Hazard and Operability, LOPA SIL</li> <li>• Risk Acceptability Criteria</li> <li>• Risk to the neighboring marine and other components</li> <li>• Failure probability, credible accident scenario, damage criteria,</li> </ul>			


	<ul style="list-style-type: none"> <li>Worst case accident Scenarios, effect on population.</li> <li>Probit function analysis, Event Frequency Estimation.</li> </ul> <p>Industrial Safety Auditing &amp; Safety Monitoring : Concept &amp; Importance of Safety Audit, Types of Safety Audit, Standards on Safety Audit: Health &amp; Safety Monitoring: ISO 45001: 2018 (Occupational Health &amp; Safety Management System)</p>	
<b>Unit-IV</b>	<p><b>Hazards and Safety Study of Various Organizations- Practicals</b></p> <p>Study Industrial Safety and Hazard Operations of different industries. Model the Hazard and Safety of hypothetical Industrial Unit. Study and model the Hazard and Safety of Commercial and Educational Institutes</p>	30 hrs
REFERENCES		
16.	Chatterji, M.M.M (1998): Environment & Health in Developing Countries. APH Publication Co., New Delhi.	
17.	Hoffman DJ, Rattner BA, Burton CA, Jr., Cairns J, Jr.: Handbook of Ecotoxicology, Lewis Publishers (2003)	

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B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)					
YEAR	III	<b>Elective 1</b>		CREDIT	4
Semester	I	<b>ENV150 : Environmental Microbiology</b>		HOURS	
OBJECTIVES:		<ol style="list-style-type: none"> <li>To explore the fundamentals of Microbial Kingdom</li> <li>To study the impacts of Microbes on the Environment.</li> </ol>			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>Unit – I</b>	<b>Diversity of Microorganisms</b>				15h
	Classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three Domain classification systems and their utility. General characteristics of different groups: Acellular microorganisms (viruses, viroids), cellular microorganisms (Prokarya: Archaea and Eubacteria; Eukarya : Algae, fungi and protozoa) and prions - giving definitions and citing examples.				
<b>Unit – II</b>	<b>Environmental Health</b>				15h
	Definition of health, relationship between environment and health, geography of risk, changing health threats and drivers of change, Communicable and non-communicable, Global health patterns. Sources of environmental pathogens, modes of transmission of pathogens and epidemiological investigations. Prevention and control of infectious diseases				
<b>Unit-III</b>	<b>Interactions in Microbial world</b>				15h
	Definitions and examples of important microbial interactions – Mutualism, Commensalism, Parasitism, Ammensalism, Antagonism, Predation, Protocooperation & Neutralism. Symbiotic N <sub>2</sub> fixers, Non-Symbiotic Nitrogen Fixers, Phosphate Solubilizers, Types of mycorrhizae and associated plants				
<b>Unit IV</b>	<b>Practical Training on Cultures</b>				30 h


	Aseptic transfer of cultures Streak Plate, Pour plate and spread plate techniques Pure Culture v/s Mixed Culture Maintaining Stock Cultures Isolation and culture of moulds (Fungi)	
<b>REFERENCES</b>		
1.	Pelczar, M., Reid, R. and Chan, E. (1957) Microbiology. T.M.H. Edition, Tata McGraw-Hill Publishing Company Ltd.	
2.	R. M. Atlas, A. Horowitz, M. Krichevsky and A. K. Bej, Principles of Microbiology, Brown Publishers.	
3.	Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ 9th edition, Mc Graw Hill Publishers.	

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B.Sc. (Hons. with Research) Environmental Science: HPP					
YEAR	III	<b>Elective 2</b>		CREDIT	4
Semester	I	<b>ENV150 : Environmental Biotechnology</b>		HOURS	
OBJECTIVES:		4. To introduce the basics of Biotechnology 5. To study Environmental aspects of Applied Biotechnology			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>		<b>Basics of Biotechnology</b>			15 hrs.
		<ul style="list-style-type: none"> <li>• Methods for measuring nucleic acid and protein interactions; Isolation &amp; Cloning of Gene of Interest</li> <li>• Polymerase Chain Reaction (PCR) and Nucleic acid hybridization (southern, northern, western blotting techniques); Methodology of Introduction of desired genes into hosts like microorganisms, plants and animals, Molecular markers</li> <li>• Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, <i>Agrobacterium</i> - mediated delivery</li> <li>• Sanger's method of DNA Sequencing: traditional and automated sequencing, and shotgun sequencing</li> </ul>			
<b>UNIT-II</b>		<b>Applications of Biotechnology -1</b>			15 hrs.
		<b>Bio-insecticides &amp; Biopesticides:</b> Introduction & Types of microbe-based bioinsecticides, their advantages over synthetic pesticides (target specificity, environmental safety, and integrated pest management); <i>Bacillus thuringiensis</i> : toxin production and field applications, Nucleopolyhedroviruses (NPVs) – application and use <b>Bio-fertilizers:</b> their advantages over chemical fertilizers, Composting, vermicomposting, and the use of microbial cultures. <i>Trichoderma</i> , <i>Metarhizium</i> . Nitrogen fixing – <i>Azotobacter</i> , <i>Rhizobium</i> , <i>Azolla</i> , <i>Frankia</i> , Cyanobacteria and <i>Azospirillum</i> , Phosphate solubilizing Microorganisms, Vesicular Arbuscular Mycorrhiza (VAM)			

	Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, and removal of heavy metals from aqueous effluent. hydrocarbons in oil spills	
<b>Unit 3</b>	<b>Industrial Microbiology</b> Definition of fermentation, primary and secondary metabolites, types of fermentations, Microbial polysaccharides and polyesters, Bioplastics, Microbial biosensors <b>Biofuels:</b> Different generations of biofuel, Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture	15h
<b>Unit IV</b>	<b>Microbiological Isolation and Bacterial Growth Analysis</b> Spectrophotometrically Studying Bacterial Growth Curve Replica Plating Determination of quality of water sample (Coliform test) MBRT Test for Milk Differential Staining of bacteria Colony Morphology Studies Isolation of microorganisms from polluted soil/Industrial effluents	30h
REFERENCES		
1.	Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press	
2.	Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K	
3.	Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K	

		<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Environmental Studies Sir C. V. Raman Building, <a href="mailto:head-env@msubaroda.ac.in">head-env@msubaroda.ac.in</a>		ACADEMIC YEAR	
B.Sc. (Hons. with Research) Environmental Science: HPP					
YEAR	III	<b>Elective 3</b>		CREDIT	4
Semester	I	<b>ENV150 : Environmental Economics</b>		HOURS	
<b>OBJECTIVES:</b>		This paper introduces students to the fundamentals of environmental economics. It covers some basic concepts of economics to familiarize students with absence of market, demand and supply in nature. Each unit covers a range of topics, which will help students develop modern concepts of environmental economics and its importance in conservation of biodiversity and ecosystems through understanding of economic costs associated with these.			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>	<b>Environmental economics</b>				15 hrs.
	Main characteristics of environmental goods; marginal analysis; markets and market failure; social benefit, costs and welfare functions; meaning and types of environmental values; measures of economic values; tangible and intangible benefits; Pareto principle or criterion; Hardin's Thesis of 'The Tragedy of Commons'; prisoner's dilemma game; methods of abatement of externalities; social cost benefit analysis; cost-effectiveness analysis.				
<b>UNIT-II</b>	<b>Economic solutions to environmental problems for Industries</b>				15 hrs.

	Social costs and benefits of environmental programmes: marginal social benefit of abatement,; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system. Economics of Recycling and waste management. E waste management and economics WTO and Environmental issues	
<b>UNIT-III</b>	<b>Natural resource economics</b>	15 hrs
	Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.	
<b>UNIT-IV</b>	<b>Tools for environmental economic policy</b>	15 hrs
	Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost benefit analysis and valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.	
<b>REFERENCES</b>		
1.	Hanley, N., Shogren, J. F., & White, B. 2007. Environmental Economics: In Theory and Practice. Palgrave Macmillan.	
2.	Kolstad, C.D. 2010. Environmental Economics. Oxford University Press.	
3.	Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B.O., Levin, S., Maler, K.G., Perrings, C., Pimentel, D. 1995. Economic growth, carrying capacity, and the environment. Ecological Economics 15: 91-95. Perman, R. 2003.	
4.	Natural Resource and Environmental Economics. Pearson Education. Singh, K. & Shishodia, A. 2007.	
5.	Environmental Economics: Theory and Applications. Sage Publications. Thomas, J.M. & Callan, S.J. 2007. Environmental Economics. Thomson Learning Inc. Tietenberg, T. 2004.	
6.	Environmental and Natural Resource Economics (6th Edition). Pearson Education Pvt. Ltd. Tietenberg, T. H. & Lewis, L. 2010.	

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	<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>				
<b>YEAR</b>	<b>III</b>	<b>Skill Enhancement Course: Theory+ Practical  Research Methodology and Environmental Statistics</b>	<b>CREDIT</b>	2	
<b>Semester</b>	<b>II</b>		<b>HOURS</b>	45	
<b>OBJECTIVES:</b>	1. Understand need of research and research methodology 1. Learn data analysis and validation				
<b>COURSE CONTENT / SYLLABUS</b>					
<b>Unit – I</b>	<b>Introduction to research methodology</b>				15 hrs.


	<ul style="list-style-type: none"> <li>• 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</li> <li>• Experimental Design: Concept of Independent &amp; Dependent variables.</li> <li>• Sampling-Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample &amp; Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.</li> <li>• Hypothesis - Qualities of a good Hypothesis –Null Hypothesis &amp; Alternative Hypothesis</li> </ul>	
<b>Unit – II</b>	<b>Environmental statistics</b>	30 hrs.
	<ul style="list-style-type: none"> <li>• Sampling process of Environmental Components</li> <li>• Hypothesis testing</li> <li>• Multivariate Analysis on collected environmental data- Z-test, F- test and ANOVA</li> <li>• Computer-based modeling: Regression, validation and forecasting.</li> <li>• Measures of central tendency, measures of dispersion (Range, quartile and standard deviation) Skewness, Correlation</li> </ul>	
<b>REFERENCES</b>		
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	

**B.Sc. Environmental Science**  
**Proposed Syllabus to be implemented from**  
**AY -2025**


**SS BSC III**

Paper Code	Paper Name	Components (Credit)		Total Credit
<b>Major</b>		<b>Theory</b>	<b>Practical</b>	
<b>ENV1601PT</b>	Ecological Assessment and Conservation	3	1	4
<b>ENV1602PT</b>	Land Degradation, Management, Sustainable Landscape, Urban planning	3	1	4
<b>ENV1603PT</b>	Environmental Legislation & EMS	3	1	4
<b>Electives (Any 2)</b>				<b>4</b>
<b>Elective 1</b>	Environmental Policies & Frameworks	2	0	2
<b>Elective 2</b>	Fundamentals of Carbon Neutrality & Zero Carbon Energy	2	0	2
<b>Elective 3</b>	Emerging contaminants and their management	2	0	2


<b>AEC: Ability Enhancement Course</b>				<b>2</b>
<b>ENV1601 AEC</b>	Scientific Communication and Ethics	2	0	2
<b>Internship</b>	Internship in Industry/ Extension Activities			4
<b>Total</b>				<b>22</b>

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<p style="text-align: center;">B.Sc. (Hons. with Research) Environmental Science: HPP</p>						
YEAR	III	<b>Major: Principal Theory and Practical</b> <b>ENV1601PT: Ecological Assessment and Conservation</b>			CREDIT	4
Semester	II				HOURS	75
<b>OBJECTIVES:</b>		<ol style="list-style-type: none"> <li>1. Study of basic aspects of ecology, population demography, factors affecting the population distribution</li> <li>2. Understanding of Ecological community and the interactions</li> <li>3. Knowledge about necessity of biodiversity conservation and the management strategies</li> <li>4. Learn about Biodiversity legislation and Policies</li> </ol>				
<b>COURSE CONTENT / SYLLABUS</b>						
<b>UNIT-I</b>	<b>Ecological assessment and its principles</b>					15 hrs.
	Biodiversity, Levels or types, Principles of conservation, Values of Bio diversity, Hotspots of biodiversity, Evaluation of conservation priorities (A. In-situ B. Ex-situ), Economic and Ecological Valuation of Biodiversity					
<b>UNIT-II</b>	<b>Theories of population and significance of biodiversity</b>					15 hrs.
	Theories of population demography, Organismic and individualistic population theories, Meta-populations and their spatial dynamics, Corridors and buffer zones, Classification of interaction between the species, Significance of complexity in trophic levels					
<b>UNIT-III</b>	<b>Biodiversity conservation related legislation and policies</b>					15 hrs.
	Approaches for biodiversity conservation (Restoration and Translocation), National and International conservation projects in India, Biodiversity Law, Legislation, Treaties and Policies: Biodiversity Conventions, Biodiversity Boards, Biodiversity Act, Wildlife Conservation Act, Wildlife Trade Act					
<b>UNIT-IV</b>	<b>Practical: Community assessment techniques and biodiversity conservation</b>					30 hrs
	1. Field ecology techniques for biodiversity quantification, various assessment methods and indices					


	<ol style="list-style-type: none"> <li>2. Wildlife census: Primary sighting, Camera trapping, Drone surveys. Secondary information like; pug marks, scat sampling, wildlife movement information, etc.</li> <li>3. Bird census, Mammal census</li> <li>4. Determine community structure: Habitat association, Niche measurement and resource preferences, carrying capacity</li> </ol>	
<b>REFERENCES</b>		
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.	


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<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>					
YEAR	III	<b>Major: Principal Theory and Practical</b>		CREDIT	4
Semester	II	<b>ENV1602PT: Land Degradation, Management, Sustainable Landscape, Urban planning</b>		HOURS	75
<b>OBJECTIVES:</b>		<ol style="list-style-type: none"> <li>1. To introduce consequences of land degradation caused by anthropogenic activity</li> <li>2. To acquaint the students with latest land management policies with case studies</li> <li>3. To create an awareness of the context in which planning operates.</li> <li>4. To impart knowledge towards creating safe and just society with specific focus on policies related to land, its allocation, implementation mechanisms and related aspects.</li> <li>5. To develop understanding of long term implications of planning decisions.</li> <li>6. To develop competence to apply knowledge at different levels in a wide range of situations with an objective to achieve planned development.</li> <li>7. To develop sensitivity towards diversity and conflicting interests in planning</li> </ol>			
<b>COURSE CONTENT / SYLLABUS</b>					
<b>UNIT-I</b>		<b>Land Degradation and Management</b>			15 hrs.
		<ul style="list-style-type: none"> <li>• Indian soils: Characteristics, types, rock cycle and weathering effect. Land degradation, desertification and their root causes: Deforestation, overgrazing, salination, faulty methods of agriculture, water logging and landslides. Consequences of land degradation: Food and water insecurity, Impacts on lives, Economic impacts</li> </ul>			


	and biodiversity loss	
	<ul style="list-style-type: none"> <li>Land management: Definition, Policy, Challenges, Issues and Solutions.</li> </ul> Case studies (Indian and International) based on land degradation and desertification.	
UNIT-II	<b>Landscape Planning</b>	15 hrs.
	Basics of landscape ecology and green spaces, classification its principles and application. Regional, Urban and Zonal scale landscape planning and assessment exercises to better address the landscape utilization. Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects	
UNIT-III	<b>Urban Planning and environmental management</b>	15 hrs.
	Urban planning and its environmental aspects from historical and contemporary perspectives; benefits of environmental management; Introduction to green buildings: Description of the LEED (Leadership in Energy and Environmental Design) Green Building Rating System; urban governance; political complexity of applying ecological science to urban policy and Planning, smart cities. Environmental costs of urban infrastructure. Energy consumption and waste disposal as well as accumulation. Sustainable use of Water & Land Resources	
UNIT-IV	<b>Soil Analysis and Housing Studies -Practicals</b>	30 hrs
	Determination of CEC and AEC of soils, Determination of point of zero-charge, Potentiometric and conductometric titration of soil humic and fulvic acids, (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the D (E4/E6) values at two pH values, Determination of titratable acidity of an acid soil by BaCl <sub>2</sub> -TEA method, , Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement of an alkali soil Housing cluster and residential sector studies – layout, density, and utility network and community facilities locations.	
<b>REFERENCES</b>		
1.	Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.	
2.	Anderson.J, Druston .B. Thesis and Assignment Writing, Wiley Eastern Pvt Ltd., New Delhi	
3.	Ott W.R. (1995). Environmental Statistics and Data Analysis, CRC Press	

	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Environmental Studies Sir C. V. Raman Building, <a href="mailto:head-env@msubaroda.ac.in">head-env@msubaroda.ac.in</a>		ACADEMIC YEAR	
	B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)			
YEAR	III	<b>Major: Principal Theory and Practical ENV1603PT : Environment Management System, Environmental Legislation and Life Cycle Assessment</b>	CREDIT	4
Semester	II		HOURS	75
OBJECTIVES	<ul style="list-style-type: none"> <li>Understand how to manage the environment, and how to meet regulatory requirements</li> <li>Learn about the legal requirements for environmental management</li> <li>Learn how to evaluate the environmental impact of products throughout their life cycle</li> </ul>			


<b>COURSE CONTENT / SYLLABUS</b>		
<b>Unit – I</b>	<b>Introduction to Environment Management</b>	15 hrs.
	a. Introduction to the evaluation tools, environmental management system (EMS), EMS definition, Environment Policy and components of EMS. b. Identification of environmental aspects and impacts. c. Organizational barriers, management responsibility, elements and extent of application, EMS structure	
<b>Unit – II</b>	<b>Environmental Legislations and Regulations</b>	15 hrs.
	a. Salient features of EIA legislation and other statutory obligations Environmental decision making in India: b. Prediction and assessment of impact on the land, air, water, noise, biological and socioeconomic environments c. Environmental clearance procedures and national requirements. d. Legal and other requirements Training and awareness requirements e. Application of Environmental Standards- ISO standards and history of their development.	
<b>Unit – III</b>	<b>Life Cycle Assessment</b>	15 hrs.
	a. Components of LCA b. Measuring environmental impact life-cycle stages of product, boundaries, functional unit. c. Issues at each life-cycle stage, benefits of LCA, d. Strategic framework for LCA and LCA-a tool for sustainability. e. Case studies	
<b>Unit-IV</b>	<b>Practical Aspects of EIA and Environmental Maanagement</b> EIA Report writing with case studies Review and observations on Public Participation and Public Hearing Implementation of Environmental Management	30 hrs
<b>REFERENCES</b>		
1.	<b>Barthwal R.R. (2002): Environmental Impact Assessment, New Age International (P) Ltd . Pub New Delhi.</b>	
2.	<b>Agrawal S.K.(2002) Pollution Management- (Vol-3), A.P.H publishing</b>	
3.	<b>Gabriele Crognale P.C (1999). Environmental management strategies (The 21st century perspective) Printice Hall PTR</b>	
4.	<b>Prabhakar V.K. (2001) Environmental Management. Anmol Publication pvt ltd.</b>	
5.	<b>Kuhre W.L. (2000) ISO 14031 Environmental performance evaluation EPE,Prentice Hall, PTR.Upper Saddle River N.J.</b>	

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	<b>B.Sc. (Hons. with Research) Environmental Science: HPP (NEP)</b>		
<b>YEAR</b>	<b>III</b>	<b>Ability Enhancement Course: Theory</b>	<b>CREDIT</b>   <b>2</b>

Semester	II	Scientific Communication and Ethics	HOURS	30	
OBJECTIVES:		1. Learn scientific communication and ethics 2. Improve presentation and communication skills			
<b>COURSE CONTENT / SYLLABUS</b>					
UNIT-I	<b>Scientific writing</b>			15 hrs.	
	<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> </ul>				
UNIT-II	<b>Scientific communication and Ethics</b>			15 hrs.	
	<ul style="list-style-type: none"> <li>Impact factor of Journals</li> <li>When and where to publish?</li> <li>Ethical issues related to publishing,</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>				
REFERENCES					
1.	Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.				
2.	Anderson.J, Druston .B. Thesis and Assignment Writing, Wiley Eastern Pvt Ltd., New Delhi				
		<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Environmental Studies Sir C. V. Raman Building, <a href="mailto:head-env@msubaroda.ac.in">head-env@msubaroda.ac.in</a>		ACADEMIC YEAR 2025-2026	
B.Sc. (Hons. with Research) Environmental Science: HPP					
YEAR	III	<b>Minor: Theory</b>		CREDIT	4
Semester	II	<b>ES Minor XXX: Environmental Policies &amp; Frameworks</b>		HOURS	30
OBJECTIVES :		1. To understand significant environmental policies 2. To develop skills in critical thinking and policy analysis 3. To Understand the policy process			
<b>COURSE CONTENT / SYLLABUS</b>					
UNIT-I	<b>Introduction to policymaking</b>			15 h	
	<ul style="list-style-type: none"> <li>Introduction to environmental jurisprudence</li> <li>Designing environmental policies- Examining the role of government agencies, stakeholders, and the public in the environmental policy-making process.</li> <li>Role of policies in addressing environmental issues</li> </ul>				
UNIT-II	<b>Environmental Policies and Corporate Responsibility</b>			15 h	

	<ul style="list-style-type: none"> <li>Corporate Environmental Responsibility (CER) and Environmental, Social, and Governance (ESG) metrics</li> <li>The role of multinational corporations in shaping environmental policies</li> <li>Public-private partnerships in environmental protection</li> </ul>			
<b>UNIT-III</b>	<b>Local and Regional Environmental Governance</b>	15 h		
	<ul style="list-style-type: none"> <li>The role of local governments in environmental policy; Evolution of policy frameworks in India- National Forest Policy 1952, National Forest Policy 1988.</li> <li>The challenges of local-level implementation of national and international frameworks</li> <li>Examining policy tools for future challenges</li> </ul>			
<b>UNIT-IV</b>	<b>Environmental Frameworks and Case Studies</b>	15 h		
	<ul style="list-style-type: none"> <li>Environmental justice and equity</li> <li>Gender equality and the environment</li> <li>Environmental activism</li> <li>Case studies- National Environmental Policy, UNFCC.</li> <li>Global and national environmental frameworks</li> </ul>			
<b>REFERENCES</b>				
1.	Divan S. and Rosencranz A. (2005) Environmental Law and Policy in India, 2 nd ed., Oxford, New Delhi			
2.	Roberts, J (2011). Environmental Policy (2nd Ed.). Routledge: Abingdon, Oxon.			
3.	Dwivedi, O P (1997). India's Environmental Policies, Programmes and Stewardship. Palgrave Macmillan: London, UK.			
4.	McGuire, C. J. (2014). Environmental Law from the Policy Perspective: understanding how legal frameworks influence environmental problem solving. Routledge.			
	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Environmental Studies Sir C. V. Raman Building, <a href="mailto:head-env@msubaroda.ac.in">head-env@msubaroda.ac.in</a>	<b>ACADEMIC  YEAR  2025-2026</b>		
<b>B.Sc. (Hons. with Research) Environmental Science: HPP</b>				
<b>YEAR</b>	<b>III</b>	<b>Minor: Theory</b>	<b>CREDIT</b>	<b>4</b>
<b>Semester</b>	<b>II</b>	<b>ES Minor XXX: Emerging Contaminants and their Management</b>	<b>HOURS</b>	<b>30</b>
<b>OBJECTIVES:</b>	To impart knowledge on <ul style="list-style-type: none"> <li>priority list of emerging contaminants and improve understanding of their sources, occurrence, distribution,</li> <li>environmental fate, transport and underlying mechanisms of emerging contaminants</li> <li>existing regulations/policies, analysis and screening techniques for CECs</li> <li>modelling frameworks, ecotoxicity, risk assessment tools and remediation technologies for CECs</li> </ul>			
<b>COURSE CONTENT / SYLLABUS</b>				
<b>UNIT-I</b>	<b>Introduction to CECs and their Fate and Transport</b>			<b>15 h</b>

	Introduction to Contaminants of Emerging Concern (CECs) Priority vs. Emerging Contaminants, Types and sources of CECs: industrial chemicals, pesticides and pharmaceutically active compounds Plastics/microplastics, endocrine disruptors, nanomaterials and other CECs	
UNIT-II	Transport and transformation processes of CECs	15 h
	Sorption - leaching - runoff - erosion - volatilization - plant/animal uptake - degradation and transformation - human health and ecological risks - environmental fate modelling frameworks basic ecotoxicology	
UNIT-III	<b>Characterization and Management strategies of CECs</b>	15 h
	<b>Sampling and Characterization</b> Sampling – sample preparation methods – analytical protocols for detection of pharmaceuticals, personal care products, antimicrobials and antibiotics, hormones, phthalate plasticizers and degradation products, surfactants, brominated fire retardants, pesticides and nanoparticles biomonitoring and biosensors	
UNIT-IV	<b>Management strategies for CECs</b>	15 h
	Risk management approach and regulatory perspectives Tools to assess environmental impacts and Risk assessment of CECs Advanced and combined treatment methods: Incineration - sonolysis - multi-phase extraction - permeable reactive barrier - advanced oxidation processes - membrane based separation - nanofiltration - Reverse osmosis - biosorption - bioaugmentation - combined treatment options Case studies. Challenges and Perspectives	
REFERENCES		
1.	Morin-Crini, Nadia, Eric Lichtfouse, and Grégorio Crini. Emerging Contaminants Vol. 1. (65). Springer International Publishing, 2021.	
2.	Bell, Caitlin H., et al. (ed.). Emerging contaminants handbook. CRC Press, 2019..	
3.	Dunnivant, Frank M., and Elliot Anders. Pollutant fate and transport in environmental multimedia. John Wiley & Sons, 2019	
4	Compton, Paul, et al., eds. Environmental management in practice: Vol 1: Instruments for environmental management. Routledge, 2013.	
5	Hernandez Maldonado, Arturo, and Lee Blaney, eds. Contaminants of emerging concern in water and wastewater: advanced treatment processes. Butterworth-Heinemann, 2019.	

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	B.Sc. (Hons. with Research) Environmental Science: HPP				
YEAR	II	<b>Minor: Theory</b> <b>ES MinorXXX: Fundamentals of Carbon Neutrality &amp; Zero Carbon</b> <b>Energy</b>	CREDIT	4	
Semester	II		HOURS	30	

OBJECTIVES:	This paper introduces students to the fundamentals Net Zero Basics: Gain a clear Understanding of what of what Net Zero means, why it matters, and the goal of balancing carbon emissions. Learn Nature-Based Solutions: Explore practical applications of Nature-Based Solutions in infrastructure to combat climate change and enhance sustainability. Discover Strategies for Net Zero: Discover various strategic approaches to achieve Net Zero, including renewable energy and sustainable practices. Address Decarbonisation Challenges: Identify and address common challenges in adopting Net Zero, considering factors like technology, finances, and organizational culture.	
<b>COURSE CONTENT / SYLLABUS</b>		
<b>UNIT-I</b>	<b>Introduction to Climate Change and Carbon Footprint</b>	15 hrs.
	Basics of climate change: causes, consequences, and global context Greenhouse gases: sources, effects, and global warming potential Concept of the carbon cycle, ecological footprint, carbon footprint and carbon rainbow Carbon footprint of individuals, organisations, and products Tools and methodologies to calculate carbon footprints (GHG Protocol, calculators) India specific Green House Gas Programs (National Action Plan on Climate Change (NAPCC) and Low Emission Development Strategy (LEDS)	
<b>UNIT-II</b>	<b>Carbon Neutrality, Net Zero and Sustainable Development Goals (SDGs)</b>	15 hrs.
	Defining carbon neutrality, net zero, and climate-positive strategies Scope 1, 2, and 3 emissions in carbon accounting Carbon offsetting and sequestration; Natural carbon sinks, carbon offsetting mechanisms Interlinkages of SDGs with climate policies and low-carbon development Carbon credits and offset markets. Corporate net zero commitments	
<b>UNIT- III</b>	<b>Zero Carbon Energy</b>	15 hrs.
	Definition and Difference between Zero carbon energy and renewable energy. Role of renewable energy in reducing carbon emissions. Energy transition and Sustainability goals. Zero carbon challenges and Opportunities in renewable energy development (Solar, Wind, Hydro, Bioenergy, Geothermal, Tidal, and Hydrogen).	15 hrs.
<b>Unit IV</b>	<b>Case Studies</b>	
	Personal and institutional carbon footprint assessment Carbon-neutral cities and corporate net-zero goals Understanding emissions related to educational institutions, IT, Real estate, Fuel supply and Airports Calculation of Emissions Reduction in buildings from Architectural Design, Material Selection Daylighting and Ventilation Strategies	
<b>REFERENCES</b>		
1.	Opportunities to reduce greenhouse gas emissions of infrastructure, Infrastructure Victoria, September 2023.	
2.	Reducing the carbon footprint of Senegalese cattle systems through improved productivity', Gareth Salmon, November 2017.	
3.	Reshaping infrastructure for a net zero emissions future, Clean Energy Finance Corporation, March 2022.	
4.	Guide to assessing greenhouse gas emissions, March 2024.	
5.	Valuing emissions for economic analysis, February 2024. Net Zero Strategy: Build Back Greener - <a href="https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf">https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf</a>	

