Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati.

(Empowered Autonomous)

Three/Four Year Honours / Honours with Research B.Sc. Degree

Program in Environmental Science

(Faculty of Science)

CBCS Syllabus

T.Y.B.Sc. (Environmental Science) Semester-V

For Department of Environmental Science

NEP 2.0

Choice Based Credit System Syllabus (2023Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2025-2026

Title of the Programme: B.Sc. (Environmental Science)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, and ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationa comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Environmental Science and related subjects, the Board of Studies in Environmental Science at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of F.Y.B.Sc. Environmental Science which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, UGC (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

In today's rapidly changing world, a Bachelor's degree in Environmental Science offers ample opportunities for individuals passionate about making a positive impact on the environment and understanding the interrelated systems governing the planet. As the global population surges and natural resources dwindle, the need for professionals skilled in environmental management, conservation, and sustainable development has never been more critical. With a strong foundation in critical thinking, problem-solving, and interdisciplinary understanding, Environmental Science graduates can pursue a wide range of rewarding careers in various sectors.

One of the most prominent careers in this field is that of an Environmental Scientist. This role entails conducting research and analysis to identify, monitor, and mitigate environmental hazards, develop sustainable land, water, and waste management practices, and inform public policy on environmental conservation. Industries such as mining, oil and gas, chemical production, and urban development actively seek Environmental Scientists to ensure compliance with environmental regulations and reduce their ecological footprint.

Environmental Consulting is another avenue that combines scientific knowledge and problem-solving abilities to help businesses, nonprofits, and governments develop eco-conscious strategies and innovative solutions to mitigate environmental risks. These consultants play a crucial role in developing and implementing sustainable practices that meet legislative and social expectations. Environmental education and awareness are now more significant than ever. Environmental Science graduates can contribute as educators in schools, colleges, and community organizations, creating environmentally literate citizens that can make informed decisions about the planet's future.

Overall, revising the Environmental Science syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Programme Specific Outcomes (PSOs)

PSO1. Critical Thinking- Students will demonstrate an understand major concepts of Environment in association with multidisciplinary subjects such as physics, chemistry and mathematics etc. Understood the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevance in the day-to-day life.

PSO2. Effective Communication- Development of various communication skills such as reading, listening, speaking, etc., which we will help in expressing ideas and views clearly and effectively.

PSO3. Social Interaction- Development of scientific outlook not only with respect to science subjects but also in all aspects related to life.

PSO4. Effective Citizenship- Imbibe moral and social values in personal and social life leading to highly cultured and civilized personality.

PSO5. Ethics- Follow the ethical principles and responsibilities to serve the society.

PSO6. Environment and Sustainability- Understand the issues of environmental contexts and sustainable development.

PSO7. Self-directed and Lifelong learning- Students will be capable of self- paced and self-directed learning aimed at personal development and for improving knowledge/skill development.

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Empowered Autonomous)

Board of Studies (BOS) in Environmental Science

From 2025-26 to 2027-28

Sr.No.	Name	Designation
1.	Ms. Surashri Sonawane	Chairman
2.	Ms. Aruna Kadam	Member
3.	Prof. Dr.Ajit Telave	Member
4.	Dr. Deepali Nimbalkar	Expert from SPPU
5.	Dr. Asawari Jadhav	Expert from other University
6.	Dr. Rachana Ingavale	Expert from other University
7.	Dr. Ganesh Kadam	Industry Expert
8.	Ms. Bhavana Upadhyay	Alumni
9.	Ms. Vaishnavi Lonkar	Student Representative

Course Structure for F.Y.B.Sc. Environmental Science (2024 Pattern)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
I	DSC-I (General)	-101-GEN	-------	Theory	04
	DSC-II (General)	-101-GEN	-------	Theory	04
	DSC-III(General)	ENV-101-GEN	Basics of Environmental Science	Theory	02
		ENV-102-GEN	Environment Science Practical-I	Practical	02
	Open Elective (OE)	ENV-103-OE	Disasters and their Management	Theory	02
	Skill Enhancement Course (SEC)	ENV-104-SEC	Introduction to lab instruments	Practical	02
	Ability Enhancement Course (AEC)	ENG-104-AEC	-----	Theory	02
	Value Education Course (VEC)	ENV-105-VEC	Environmental Education	Theory	02
	Generic Indian Knowledge System (GIKS)	GEN-106-IKS	------	Theory	02
				Total Credits	**22**
II	DSC-I (General)	-151-GEN	-----	Theory	04
	DSC-II (General)	-151-GEN	-----	Theory	04
	DSC-III (General)	ENV-151-GEN	Fundamentals of Environmental Biology	Theory	02
		ENV-152-GEN	Environment Science Practical-II	Practical	02
	Open Elective (OE)	ENV-153-OE	Environmental Management and Safety	Practical	02
	Skill Enhancement Course (SEC)	ENV-154-SEC	Sustainable Agricultural Practices	Practical	02
	Ability Enhancement Course (AEC)	ENG-154-AEC	----	Theory	02
	Value Education Course (VEC)	COS-155-VEC	Digital and technological solutions	Theory	02

	CC	YOG/PES/CUL/NSS/NCC-156-CC	To be selected from the CC Basket	Theory	02
				Total Credits	**22**
				Grand Total Sem I + Sem II	**44**

Course Structure for S. Y. B. Sc. Environmental Science Semester III and IV (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
III	Major Mandatory	ENV-201-MJM	Natural Resources and Management	Theory	02
	Major Mandatory	ENV-202-MJM	Environmental Pollution-I	Theory	02
	Major Mandatory	ENV-203-MJM	Wildlife and Conservation	Theory	02
	Major Mandatory	ENV-204-MJM	Environmental Science Practical-III	Practical	02
	Minor	ENV-211-MN	Man and Environment	Theory	02
	Minor	ENV-212-MN	Basic Practicals in Environmental science	Practical	02
	Open Elective (OE)	ENV-116-OE	Initiatives for Environmental Management	Theory	02
	Vocational Skill Course (VSC)	ENV-221-VSC	Organic Farming	Theory	02
	Ability Enhancement Course (AEC)	MAR-231-AEC HIN-231-AEC SAN-231-AEC	भाषिक उपयोजन व लेखन कौशल्ये हिंदी भाषा कौशल प्राथमिक संभाषण कौशल्यम	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-239-CC	To be selected from the Basket	Theory	02
	Field Project (FP)	ENV-235-FP	Field Project	Practical	02
	Generic IKS Course (IKS)	GEN-245-IKS	Indian knowledge System (Generic)	Theory	02
	Total Credits Semester-III				**22**
IV	Major Mandatory	ENV-251-MJM	Solid and Hazardous Waste Management	Theory	02
	Major Mandatory	ENV-252-MJM	Environmental Pollution-II	Theory	02
	Major Mandatory	ENV-253-MJM	Biodiversity and its conservation	Theory	02
	Major Mandatory	ENV-254-MJM	Environment Science Practical-IV	Practical	02
	Minor	ENV-261-MN	Environmental Microbiology	Theory	02
	Minor	ENV-262-MN	Environmental Microbiology Practical	Practical	02
	Open Elective(OE)	ENV-266-OE	Eco-Friendly Practices	Practical	02
	Skill Enhancement Course (SEC)	ENV-276-SEC	Designing of Rain water harvesting	Practical	02
	Ability Enhancement Course (AEC)	MAR-281-AEC HIN-281-AEC SAN-281-AEC	लेखन निर्मिती व परीक्षण कौशल्ये हिंदी भाषा :संप्रेषण कौशल प्रगत संभाषण कौशल्यम	Theory	02

	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-289-CC	To be selected from the Basket	Theory	02
	Community Engagement Project (CEP)	ENV-285-CEP	Community Engagement Project (CEP)	Practical	02
	Total Credits Semester-IV				**22**
	Cumulative Credits Semester III + Semester IV				**46**

Course Structure for T. Y. B. Sc. Environmental Science Semester V and VI (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V	Major Mandatory	ENV-301-MJM	Ecosystem Management	Theory	02
	Major Mandatory	ENV-302-MJM	Wildlife Biology	Theory	02
	Major Mandatory	ENV-303-MJM	Geoscience	Theory	02
	Major Mandatory	ENV-304-MJM	Nature Conservation	Theory	02
	Major Mandatory	ENV-305-MJM	Practical based on ENV-301-MJM to ENV-304-MJM	Practical	02
	Major Elective (MJE)	ENV-306-MJE(A)	Environmental Governance, Laws and Ethics	Theory (Any two)	04
	Major Elective (MJE)	ENV-306-MJE(B)	Environmental Biotechnology		
	Major Elective (MJE)	ENV-306-MJE(C)	Remote sensing ,GIS and modeling		
	Minor	ENV-311-MN	Water and Soil quality	Theory	02
	Minor	ENV-312-MN	Practical based on Water and Soil quality	Practical	02
	Vocational Skill Course (VSC)	ENV-321-VSC	Practical based on Environmental Microbiology	Practical	02
	Field Project(FP)	ENV-335-FP	Field project	Practical	02
				Total Credits Semester-V	**22**
VI	Major Mandatory	ENV-351-MJM	Climate Change	Theory	02
	Major Mandatory	ENV-352-MJM	Analytical Methods	Theory	02
	Major Mandatory	ENV-353-MJM	Sustainable Development	Theory	02
	Major Mandatory	ENV-354-MJM	Environmental Statistics	Theory	02
	Major Mandatory	ENV-355-MJM	Practical based on ENV-351-MJM to ENV-354-MJM	Practical	02
	Major Elective(MJE)	ENV-356-MJE(A)	Environmental Safety and Risk Management	Theory (Any two)	04
	Major Elective(MJE)	ENV-356-MJE(B)	Environmental Economics and Audit		
	Major Elective(MJE)	ENV-356-MJE(C)	Soil Health Management		
	Minor	ENV-361-MN	Air and Noise quality	Theory	02
	Minor	ENV-362-MN	Practicals based on Air and Noise quality	Practical	02
	On Job Training(OJT)	ENV-385-OJT	On Job Training	Practical	04
				Total Credits Semester-VI	**22**
				Total Credits Semester-V+ VI	**44**

CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science

Program Code	: USENV
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ENV-301-MJM
Course Name	: **Ecosystem Management**
No. of Credits	: 2
No. of Teaching Hours	: 30

Course Objectives:

1) To learn terrestrial ecosystem and its detailed classification.
2) To learn aquatic ecosystem and its distribution.
3) To make student aware about importance of aquatic and terrestrial ecosystem.
4) Sustainability of resources and species population viability.
5) To maintain an ecosystem in a healthy, productive and resilient condition through the implementation of policies and management measures.
6) The local and geographical distribution and abundance of organisms.
7) Temporal changes in the occurrence, abundance and activities of organisms.

Course Outcomes:

By the end of the course, students will be able to:

CO1: Students understood terrestrial ecosystem and its resources.

CO2: Students understood aquatic ecosystem and their importance.

CO3: Students will demonstrate an understanding of fundamental ecological principles, such as nutrient cycling, energy flow, and biodiversity.

CO4: Students will develop strategies for the conservation and restoration of ecosystems, considering both natural and human-induced disturbances.

CO5: Students will evaluate the challenges and opportunities associated with the conservation and management of grassland and forest ecosystems.

CO6: Students will explore principles and practices of sustainable forest management, including timber harvesting, reforestation, and the conservation of old-growth forests.

CO7: Students will understand the ecological importance of wetlands, and develop strategies for the conservation and restoration of these critical habitats.

Topics and Learning Points

Teaching Hours

Unit-1-Terrestrial Ecosystem and community **10**

- Introduction, The Terrestrial Environment, The terrestrial biota and Biogeographic regions, general structure of terrestrial communities. The soil subsystem, the vegetation subsystem, parameters of the terrestrial environment, hotspots in India.
- Distribution of major terrestrial communities, patterns, classification, ecotone and edge effect, keystone species and control of community structure, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation, and mutualism.

Unit-2-Aquatic Ecosystem and community **10**

- Introduction, Limnology, Aquatic environment, aquatic biota, energy flow in aquatic ecosystem, The parameters of the aquatic environment. Major environmental factors and ecosystem processes, Ramsar convension and Ramsar site in India
- Distribution of major aquatic ecosystems classification, structure and patterns, Impact of climate change on aquatic ecosystem ecotone and edge effect, types of intcractions

Unit-3- Terrestrial and aquatic Ecosystem Management **10**

- Methods of terrestrial ecosystem management: remote sensing, geographical information system, community based forest Management, traditional methods, Forest fire: reasons, effects, control measures and management Methods of vegetation sampling and data analysis: sampling approaches, quadrate methods, line and belt transect, the point frame method.
- Methods of aquatic ecosystem management: remote sensing, geographical information system, Eco-development program, traditional methods, Methods of aquatic sampling and data analysis: sampling approaches, species association.

References:

1. Principles of Environmental science - Cunningham andCunningham
2. Ecology, Environment and Resource Conservation (2006): Singh JS, Singh SP and Gupta SR; Anamaya Publ, New Delhi.
3. Fundamental of Ecology (1971): EP Odum; WB Saunders Company.
4. Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed –2004.
5. Environmental Science; by-Santra SC; Central Publ. NewDelhi
6. Lillis and, T. M. and Keifer, R. W. (1990): Remote Sensing and Image interpretation, John Willey and Sons, New York
7. Joseph G. (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad.
8. Haywood, Ian (2000): Geographical Information Systems, Longman

9. Chang, Kang-taung (2002): Introduction to Geographic Information Systems, Tata McGraw-Hill.
10. Burroughs, P. A (1986): Principles of Geographical Information Systems for land Resource Assessment, Oxford University Press.
11. Gupta, R. P. 2003. Remote sensing geology, Springer, New York
12. Barrett, E. C. and Curtis, L. F. 1999. Introduction to environmental remote sensing. Chapman and Hall

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1		3											
CO2		3									2		
CO3										2			
CO4			3		2			3			2		
CO5						3							
CO6				3									2
CO7	3						2		2			1	

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Understanding terrestrial ecosystems and their resources provides a broad overview of ecological systems. This aligns with developing comprehensive knowledge in environmental science.

PO2: Practical, Professional, and Procedural Knowledge

CO4: Developing strategies for conservation and restoration directly correlates with applying practical knowledge in real-world environmental scenarios. This outcome also highlights procedural knowledge, especially considering human-induced disturbances.

CO6: Sustainable forest management, including timber harvesting and reforestation, involves practical application of environmental management skills.

PO3: Entrepreneurial Mindset and Knowledge

CO5: Evaluating the challenges and opportunities in grassland and forest ecosystems encourages students to consider innovative, entrepreneurial approaches to managing these ecosystems.

PO4: Specialized Skills and Competencies

CO3: Understanding fundamental ecological principles (nutrient cycling, energy flow, and biodiversity) builds specialized knowledge in ecology, developing the students' competencies in this domain.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO2: Understanding aquatic ecosystems and their importance requires students to apply ecological principles in analyzing and solving environmental issues related to aquatic environments.

CO5 & CO7: Evaluating and developing strategies for the conservation and restoration of ecosystems

requires problem-solving and analytical thinking, particularly with grasslands, forests, and wetlands.

PO6: Communication Skills and Collaboration
CO6 & CO7: The development of strategies for forest and wetland conservation will require students to effectively communicate their ideas and collaborate on sustainable management practices.

PO7: Research-related Skills
CO4: The development of strategies for ecosystem restoration necessitates research on both natural and human-induced disturbances, allowing students to strengthen their research skills.

PO8: Learning How to Learn Skills
CO3 & CO5: Understanding ecological principles and evaluating conservation challenges encourages students to adopt independent learning approaches to stay updated with new developments in ecology and environmental conservation.

PO9: Digital and Technological Skills
CO6: The principles and practices of sustainable forest management, especially with reforestation and timber harvesting, may involve the use of digital tools or technologies for forest inventory, mapping, and ecosystem management.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO7: Understanding the ecological importance of wetlands and developing conservation strategies could incorporate considerations of local communities, cultures, and inclusive practices in environmental conservation.

PO11: Value Inculcation and Environmental Awareness
CO2 & CO4: Understanding aquatic ecosystems, as well as developing strategies for ecosystem conservation and restoration, directly contributes to building an awareness of environmental issues, emphasizing sustainability and ethical responsibility towards nature.

PO12: Autonomy, Responsibility, and Accountability
CO4 & CO6: The course outcomes that involve developing conservation strategies for ecosystems require students to take responsibility and demonstrate accountability in addressing environmental challenges.

PO13: Community Engagement and Service
CO7: Conservation and restoration of wetlands and other ecosystems often involve community engagement, which reflects the students' role in contributing to societal needs through service-oriented actions.

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CBCS SYLLABUS as per NEP 2020 for T. Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science

Program Code	: USENV
Class	: T.Y. B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ENV-302-MJM
Course Name	: **Wildlife Biology**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1) To learn wildlife resource or wildlife biology.
2) To learn major group of plant and animal species and their natural habitat.
3) To learn wildlife management techniques and biodiversity hotspot.
4) Provide information and advice on specific wildlife management problems.
5) To maintain balance in ecosystem.
6) To maintain life supporting system and essential ecological processes.
7) To preserve and use natural resources in sustainable manner.

Course Outcomes:

CO1: Students get information about wildlife and their various species.
CO2: Students understanding diversity of wildlife and their scope.
CO3: Students will learn to assess different types of habitats and understand the principles of habitat management to support wildlife populations.
CO4: Students will comprehend the principles of conservation biology, including the importance of genetic diversity, habitat preservation, and the role of protected areas.
CO5: Students will be familiar with wildlife policies, laws, and regulations. They will understand the principles of wildlife management, conservation planning, and the role of stakeholders.
CO6: Students will understand and apply ethical principles in wildlife research and management, ensuring humane treatment of animals and responsible conduct in the field.
CO7: Students will demonstrate a deep understanding of wildlife ecology, including population dynamics, community interactions, and ecosystem relationships.

Topics and Learning Points

Teaching Hours

Unit-1 Introduction **10**

- Introduction, Concept of Wildlife Biology, Definition of Wildlife, examples of protected wildlife species (Refer to Wildlife Protection Act).
- Diversity of major groups of plants and animals. Plants: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocots and Dicots) Animals: Mollusca, Vertebrates- (Mammals, Birds, Fish, Reptiles, Amphibians), habitats of faunal species.

Unit-2 wildlife diversity **10**

- Wildlife Habitats Aquatic (Marine, Freshwater, Brackish) Terrestrial habitats (Vegetation types:- forest, grassland, arid zones, hot and cold deserts, agriculture, landscape patterns Examples of food chain in each type of habitat.
- Threats to Wildlife Habitat destruction, developmental projects, urbanization, agricultural expansions, excessive harvesting and poaching, human- wildlife conflict, examples of excessive exploitation of plants and animals.

Unit-3 Wildlife Management Techniques **10**

- Wildlife Management Techniques: Population assessment techniques (wildlife senses), direct count-block count, transects method ,point count method ,visual encounter survey, water hole survey,
- Indirect count: Transects, Point Counts, census from pug marks, camera trapping, DNA finger printing, track and sign, pellet count
- Marking wildlife: ringing, tagging, clipping, coloring
- Modern wildlife management techniques.

References:

1. Plant Diversity Hotspots in India (1997): PK Hajra and V. Mudgal; Botanical Survey of India
2. Environmental Management (2005): Bala Krishna moorthy; Prentice-Hall of India Pvt. Ltd., NewDelhi.
3. Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed –2004.
4. Environmental Science; by-Santra SC; Central Publ. NewDelhi
5. Raymond F Dasmann, Environmental Conservation, John Wiley (1984).

6. Kato, M. The Biology of Biodiversity, (1999), Springer Verlag, Tokyo.
7. Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and protected areas, (2002). Agro bios, India.
8. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice,
9. (2003). Oxford and IBH Publishing, New Delhi.

Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1		3											
CO2		3									2		
CO3										2			
CO4			3		2			3			2		
CO5						3							
CO6				3									2
CO7	3						2		2			1	

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Gaining information about wildlife and their various species provides foundational knowledge in wildlife science and biodiversity, aligning with PO1.

CO7: Understanding wildlife ecology, including population dynamics, community interactions, and ecosystem relationships, strengthens the comprehensive understanding of ecological processes and the complexity of ecosystems.

PO2: Practical, Professional, and Procedural Knowledge

CO3: Learning to assess different types of habitats and understanding habitat management principles directly connects with practical knowledge in wildlife management and environmental conservation.

CO5: Becoming familiar with wildlife policies, laws, and regulations helps students gain professional knowledge and understand procedural aspects of wildlife management, ensuring they are equipped for professional work in the field.

PO3: Entrepreneurial Mindset and Knowledge

CO2: Understanding the diversity of wildlife and its scope can stimulate entrepreneurial ideas for conservation efforts, wildlife tourism, and sustainable wildlife management, fostering an entrepreneurial approach to addressing ecological challenges.

PO4: Specialized Skills and Competencies

CO4: The principles of conservation biology, such as genetic diversity and habitat preservation, require specialized knowledge in biological conservation. This outcome builds the competencies necessary for students to engage in advanced wildlife conservation efforts.

CO6: Applying ethical principles in wildlife research and management contributes to specialized ethical competency in the field of wildlife science.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO3: Assessing habitats and managing wildlife populations requires practical problem-solving and analytical thinking in the context of conservation.
CO7: Understanding wildlife ecology, including population dynamics, requires analytical reasoning to interpret ecological patterns and relationships, as well as problem-solving to address wildlife management issues.

PO6: Communication Skills and Collaboration
CO5: Understanding wildlife policies, laws, and the role of stakeholders requires students to communicate effectively with various groups, such as government agencies, NGOs, and local communities, fostering collaborative efforts in conservation.
CO6: Applying ethical principles in wildlife research also involves clear communication about ethical practices, enabling collaboration with other researchers and stakeholders in wildlife conservation.

PO7: Research-related Skills
CO6: Students learn to apply ethical principles in wildlife research, which requires research skills related to humane treatment and responsible conduct in the field.
CO7: The deep understanding of wildlife ecology fosters students' research abilities, enabling them to engage in ecological studies and fieldwork focused on wildlife populations and ecosystems.

PO8: Learning How to Learn Skills
CO1 & CO2: Learning about wildlife species and their diversity enhances the student's ability to explore new areas of wildlife science, encouraging them to continue learning and stay updated with advancements in the field.
CO5 & CO6: Learning about policies, laws, and ethical principles in wildlife management promotes continuous self-learning in how to approach changing regulations, conservation strategies, and ethical standards.

PO9: Digital and Technological Skills
CO3 & CO7: Assessing habitats and understanding wildlife ecology increasingly requires the use of digital tools, GIS mapping, and other technologies. These technological skills are vital for modern wildlife conservation and habitat management.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO6: Ethical principles in wildlife research emphasize humane treatment and respect for all species, which aligns with fostering empathy and an inclusive spirit in wildlife management.
CO5: Understanding wildlife policies, laws, and stakeholder involvement includes recognizing the importance of diverse cultural perspectives and approaches to conservation.

PO11: Value Inculcation and Environmental Awareness
CO4: Understanding conservation biology principles, such as the importance of genetic diversity and habitat preservation, directly contributes to cultivating environmental awareness and instilling values of sustainability and responsibility towards wildlife.
CO7: A deep understanding of wildlife ecology helps students develop values related to ecosystem conservation and biodiversity protection.

PO12: Autonomy, Responsibility, and Accountability

CO6: Applying ethical principles in wildlife management and ensuring humane treatment of animals instills a sense of responsibility and accountability in students' actions, both in research and conservation efforts.

CO3: Assessing and managing habitats requires students to take ownership and responsibility for their impact on wildlife populations and ecosystems.

PO13: Community Engagement and Service

CO5: Understanding wildlife policies and the role of stakeholders includes engaging with local communities, government bodies, and NGOs to foster a collaborative approach to wildlife conservation and management, promoting active community involvement in wildlife protection efforts.

CO6: Ethical principles in wildlife research often involve community engagement, especially in field studies and conservation programs that impact local populations

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science
Program Code :USENV
Class : T.Y. B.Sc.
Semester : V
Course Type : Major Mandatory (Theory)
Course Code : ENV-303-MJM
Course Name : **Geoscience**
No. of Credits : 2
No. of Teaching Hours : 30

Course Objectives:

1) To learn or study the geological study of earth.
2) To make student aware about conservation natural resources.
3) To learn origin of earth, soil weathering.
4) It also helps us to study about crystal systems and how the minerals crystallized in different systems.
5) To understand the fundamental processes of the atmosphere.
6) To learn effects of the atmosphere on other aspects of the earth's environments and on humans.
7) To learn the resulting weather and climate.

Course Outcomes:

By the end of the course, students will be able to:
CO1: Students understood origin of earth and soil weathering process.
CO2: Students understood natural hazards and disaster.
CO3: Students will demonstrate a comprehensive understanding of the Earth's internal structure, including the composition and properties of the Earth's crust, mantle, and core.
CO4: Students will analyze and interpret the principles of plate tectonics, including the movement of Earth's lithospheric plates, volcanic activity, and seismic events.
CO5: Students will identify minerals and rocks, understand their formation processes, and analyze their significance in geological contexts.
CO6: Students will understand atmospheric processes, climate patterns, and weather systems, including factors influencing climate change.
CO7: Students will study the chemical composition of Earth materials, including rocks, minerals, and fluids, and their role in geological processes.

Topics and Learning Points

Unit 1- Origin and evolution of earth **Teaching Hours 10**

- Introduction, Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere, Lithosphere. Concept of minerals and rocks.
- Climates of India, Indian monsoon, droughts, El Nino, La Nina. Concept of residence time and rates of natural cycles. Geophysical fields.

Unit 2- Soil Weathering 10

- Definition, Classification, Weathering, erosion, transportation and deposition of sediments.
- Soil forming minerals and process of soil formation, Identification and characterization of clay minerals,
- Soil physical and chemical properties, soil types and climate control on soil formation, mineralogical controls.

Unit 3- Natural Hazards and Disasters 10

- Concept, Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.
- Atmospheric disturbances: Thunderstorms, cyclones, lightening, and drought.
- Impact of anthropogenic activities on nature.

References:

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2. Environmental Geology: Edward A. Keller Khanke, H.1968.
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11. Strahler, A.H and Strahler A.N (2002): Modern Physical Geography, John Wiley and Sons.
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Technology.
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15. Sharma &Vatal (1962): Oceanography for Geographers. Chaitanya Publishing House, Allahabad.
16. Basu S.K. (2003) (ed): Handbook of Oceanography, Global Vision, Delhi.
17. Kusky, T. M. 2003. Geological Hazards, Greenwood Press, Westport, Conn. London.
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Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Understanding the origin of Earth and soil weathering processes provides foundational knowledge about the planet's formation and ongoing geological processes, contributing to a comprehensive understanding of Earth sciences.

CO3: A comprehensive understanding of the Earth's internal structure (crust, mantle, and core) directly enhances the student's foundational geological knowledge.

PO2: Practical, Professional, and Procedural Knowledge

CO5: Identifying minerals and rocks and understanding their formation processes equip students with the practical skills to analyze geological samples and interpret their significance in real-world contexts.

CO7: Understanding the chemical composition of Earth materials, including rocks, minerals, and fluids, prepares students to apply professional knowledge and procedures in geological analysis.

PO3: Entrepreneurial Mindset and Knowledge

CO2: Understanding natural hazards and disasters, such as earthquakes, volcanic eruptions, and floods, encourages entrepreneurial thinking related to disaster preparedness, mitigation, and response strategies, which can have real-world business and social applications.

CO6: Climate patterns and factors influencing climate change can lead students to think about entrepreneurial ventures focused on sustainability, climate change solutions, or weather prediction technologies.

PO4: Specialized Skills and Competencies

CO4: Analyzing and interpreting plate tectonics, volcanic activity, and seismic events develop

specialized knowledge in Earth processes, enhancing competencies in geological analysis and understanding of Earth's dynamic systems.
CO5: Identifying and analyzing minerals and rocks provide specialized skills in mineralogy and petrology, crucial for geologists and Earth scientists.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO4 & CO7: The analysis of plate tectonics and the study of Earth materials require problem-solving and analytical reasoning, particularly in interpreting geological data, understanding Earth's structure, and predicting geological events or processes.
CO6: Understanding atmospheric processes and climate patterns involves problem-solving related to weather systems and climate change, encouraging analytical reasoning in forecasting and climate-related studies.

PO6: Communication Skills and Collaboration
CO3: Communicating the understanding of Earth's internal structure, including its composition and properties, requires clear explanations of complex geological concepts, fostering communication skills.
CO5: Identifying and explaining the formation of minerals and rocks also necessitates communication skills, particularly in the context of academic and professional geological reporting.

PO7: Research-related Skills
CO1 & CO4: Understanding the origin of Earth, soil weathering processes, and the principles of plate tectonics promotes research-oriented thinking, encouraging students to explore and investigate Earth's geological processes through hands-on research.
CO6 & CO7: Studying atmospheric processes and the chemical composition of Earth materials requires research skills to analyze data, interpret findings, and contribute to the body of knowledge in Earth sciences.

PO8: Learning How to Learn Skills
CO1 & CO3: The study of Earth's origin, soil weathering processes, and Earth's internal structure encourages independent learning and critical thinking, allowing students to stay curious and explore further into Earth sciences.
CO5 & CO6: Learning about minerals, rocks, and atmospheric processes motivates students to pursue self-directed learning about new geological discoveries and environmental changes.

PO9: Digital and Technological Skills
CO4: The study of plate tectonics, volcanic activity, and seismic events often involves the use of digital tools, simulation software, and geospatial technologies, thus promoting digital and technological skills in geological research and analysis.
CO7: Understanding the chemical composition of Earth materials often requires the use of laboratory technology, analytical tools, and digital data collection methods to analyze and interpret samples.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO2 & CO6: Understanding natural hazards and climate change fosters a sense of empathy toward communities impacted by these events, promoting an inclusive spirit when developing solutions for disaster preparedness or climate resilience.

CO6: The study of weather systems and climate patterns encourages awareness of how diverse global communities are affected by climate change and the importance of inclusive, culturally sensitive solutions.

PO11: Value Inculcation and Environmental Awareness

CO2 & CO6: Understanding natural hazards and climate change instills a sense of environmental responsibility and awareness of the human impact on Earth's systems, reinforcing the importance of sustainable practices and climate resilience.

CO5: Studying the formation of minerals and rocks and their geological significance helps students appreciate the Earth's natural resources, fostering environmental stewardship.

PO12: Autonomy, Responsibility, and Accountability

CO4 & CO7: Analyzing and interpreting geological processes such as plate tectonics, volcanic activity, and the chemical composition of Earth materials requires students to take responsibility for their analyses and conclusions, fostering autonomy in their academic and professional work.

PO13: Community Engagement and Service

CO2 & CO6: Understanding natural hazards and climate processes involves engaging with communities impacted by disasters and climate change. Students may collaborate with local organizations and policymakers in the application of geological knowledge to address real-world environmental challenges.

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science

Program Code	:USENV
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Practical)
Course Code	: ENV-304-MJM
Course Name	: **Nature Conservation**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1) To learn basic natural resources.
2) To learn methods for conservation of a nature.
3) To learn information about international efforts for conservation of nature.
4) The program also builds skills in conducting research and communicating for wildlife conservation.
5) To preserve and conserve natural forests which meet the basic needs of people living in or near by the forest.
6) Skill required foe assessment and monitoring of biodiversity as well as wildlife management.
7) To apply knowledge to solve problems related to wildlife conservation and management

Course Outcomes:

By the end of the course, students will be able to:

CO1: Students aware about nature conservation methods and their international efforts.

CO2: Students understood objectives and challenges of nature conservation.

CO3: Students will understand the ecological principles that govern ecosystems and develop skills in habitat management for the conservation of biodiversity.

CO4: Students will gain knowledge about the conservation of wildlife species, including endangered and threatened species, and understand the principles of captive breeding and reintroduction.

CO5: Students will understand the legal and policy frameworks related to nature conservation at local, national, and international levels.

CO6: Students will learn principles and practices related to the establishment, design, and management of protected areas for conservation purposes.

CO7: Students will explore ethical considerations in conservation decision-making, addressing issues such as the trade-off between conservation goals and human development.

Topics and Learning Points

Unit 1- Introduction to nature conservation

- Concept of Nature Conservation; Convention on Biological Diversity (CBD), Protected Area Network (PAN) in India, Details of PAN in Maharashtra state.

Unit 2-Methods of Nature conservation

- Methods: In situ-Concept, Principles, Protected area types(global and national level, Heritage sites), Examples, challenges, merits and limitations;
- Ex situ-Concept, Principles, Types (captive breeding and reintroductions, seed banks, gene banks), examples, challenges, merits and limitations;
- Traditional/community conservation-Concept, examples, challenges, merits and limitations, Roll of (NBA) National Biodiversity Authority (Roll and structure), State biodiversity board.

Unit-3 International National and efforts for Conservation (10l)

- International efforts for Conservation: Role of IUCN,WWF for nature conservation introduction to protocol and convensions for nature conservation,
- National efforts –BNHS ,tiger, crocodile
- administrative set up-MoEFCC, SPCB, CPCB etc
- Role of NGO species conservation efforts
- Awareness about nature conservation

References:

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2. Environmental Chemical Analysis Laboratory Manual, Prepared by Dr. Erik Krogh, Dr. Chris Gill, Shelley Gellein, and Peter Diamente Department of Chemistry, 2018
3. Environmental Chemistry: S. e. Manahan
4. The Chemistry of Our Environment: R. A. Hom

Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
CO1: Being aware of nature conservation methods and international efforts provides students with a comprehensive understanding of global conservation strategies and initiatives.
CO3: Understanding ecological principles and habitat management for biodiversity conservation enhances the students' grasp of ecosystems' functioning and their significance in nature conservation.

PO2: Practical, Professional, and Procedural Knowledge
CO4: Gaining knowledge about wildlife species conservation, including captive breeding and reintroduction, equips students with practical knowledge on wildlife management techniques.
CO6: Learning about the establishment, design, and management of protected areas for conservation purposes provides procedural knowledge, preparing students for real-world applications in conservation planning and management.

PO3: Entrepreneurial Mindset and Knowledge
CO2: Understanding the objectives and challenges of nature conservation encourages entrepreneurial thinking, especially in the development of sustainable solutions for conservation that balance environmental and economic interests.
CO7: Ethical considerations in conservation decision-making, including trade-offs between conservation and development, foster entrepreneurial thinking related to sustainable development and conservation projects.

PO4: Specialized Skills and Competencies
CO3: Developing skills in habitat management and understanding ecological principles directly contributes to specialized competencies in ecological conservation and biodiversity management.
CO5: Understanding legal and policy frameworks related to conservation enhances specialized skills in navigating regulatory and legislative landscapes in conservation practice.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO4: Knowledge of wildlife conservation techniques, such as captive breeding and reintroduction, requires problem-solving abilities to address challenges related to species preservation.
CO6: Understanding the design and management of protected areas encourages students to apply their knowledge to solve real-world conservation problems, such as habitat fragmentation and species protection.

PO6: Communication Skills and Collaboration
CO1 & CO5: Understanding the international conservation efforts and the legal and policy frameworks necessitates communication skills to articulate these complex systems to various stakeholders, including local communities, governments, and international organizations.
CO7: Exploring ethical considerations in conservation requires students to communicate effectively about the trade-offs between conservation goals and human development, promoting collaboration among stakeholders with diverse perspectives.

PO7: Research-related Skills
CO3 & CO4: Gaining an understanding of ecological principles and conservation methods promotes research skills in ecological studies, wildlife management, and biodiversity conservation.
CO6: Learning about protected area management fosters research-related skills, particularly in evaluating conservation effectiveness and monitoring biodiversity within protected areas.

PO8: Learning How to Learn Skills
CO2: Understanding the challenges of nature conservation encourages students to engage in self-directed learning to keep up with new research, policies, and practices in the conservation field.
CO7: Ethical decision-making in conservation requires continuous learning and reflection, as conservation practices often evolve to incorporate new ethical perspectives and data.

PO9: Digital and Technological Skills
CO6: Learning about the establishment, design, and management of protected areas often involves the use of GIS, mapping technologies, and other digital tools for land-use planning and biodiversity monitoring.
CO3: Implementing habitat management plans for biodiversity conservation may also involve using digital tools for ecosystem monitoring, habitat mapping, and data collection on species.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1 & CO7: Understanding international conservation efforts and ethical considerations in conservation decision-making fosters a multicultural approach to conservation, emphasizing inclusive practices that take into account different cultural values, traditions, and local needs.
CO5: Legal and policy frameworks related to conservation are often informed by diverse cultural perspectives, requiring students to adopt an inclusive approach when analyzing conservation laws and regulations.

PO11: Value Inculcation and Environmental Awareness
CO1 & CO3: Gaining awareness of nature conservation methods and ecological principles encourages students to develop a strong environmental ethos, fostering a deeper understanding of biodiversity's importance and sustainability.
CO4: Knowledge of wildlife conservation, especially regarding endangered species, promotes the development of values such as responsibility, ethical consideration, and commitment to preserving natural resources.

PO12: Autonomy, Responsibility, and Accountability
CO6: Learning about the design and management of protected areas requires students to take responsibility for their actions in conservation management, fostering autonomy in conservation decision-making.
CO7: Ethical considerations in conservation decision-making encourage students to act responsibly, considering the impacts of their decisions on wildlife and human communities.

PO13: Community Engagement and Service

CO2 & CO4: Understanding the challenges of nature conservation and the need for wildlife conservation efforts highlights the importance of community engagement. Students may contribute to local conservation projects, working with communities to implement solutions for species protection and habitat restoration.

CO6: The establishment and management of protected areas often involve direct community engagement to ensure successful conservation efforts, such as through sustainable livelihood programs or eco-tourism initiatives.

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science

Program Code	: USENV
Class	: T.Y. B.Sc.
Semester	: V
Course Type	: Major (Practical)
Course Code	: ENV-305-MJM
Course Name	: **Practical based on ENV-301-MJM to ENV- 304-MJM**
No. of Credits	: 2
No. of Teaching Hours	: 60

Course Objectives:

1) To aware the students about ecosystem management.
2) To enhance the knowledge of students about the environmental science.
3) To aware the students about environmental laws and ethics.
4) The local and geographical distribution and abundance of organisms.
5) Temporal changes in the occurrence, abundance and activities of organisms.
6) To maintain life supporting system and essential ecological processes.
7) To preserve and use natural resources in sustainable manner.

Course Outcomes:

By the end of the course, students will be able to:

CO1: It will help to conserve the wildlife biology.
CO2: Students will get job in GIS mapping and remote sensing.
CO3: Data analyzer will be expert to conclude the significance of biological experiments.
CO4: Students will demonstrate the ability to identify key components of ecosystems, including flora, fauna, and abiotic factors, through field observations and assessments.
CO5: Students will develop and implement strategies for the identification, control, and management of invasive species within an ecosystem.
CO6: Students will be able to analyze different statistical models.
CO7: Students will develop and implement strategies for the identification, control, and management of invasive species within an ecosystem

Topics and Learning Points

1. Study of Flora of an urban terrestrial ecosystem/herbarium.
2. Study of primary productivity from grassland community
3. Study of species interaction from forest area.
4. Study of vegetation by Belt/Line method.
5. Study of Fauna of an urban terrestrial ecosystem.
6. Quantitative analysis of phytoplanktons and determination of percent composition lockey's drop count method.
7. To calculate Shannon, Simpson, Sorenson's coefficient index.
8. Exercise based on the lapse rate.
9. Draw the simple wind roses with the help of given data.
10. Draw the Compound wind roses with the help of given data.
11. Draw the climatic maps and diagram of climograph /circular graph.
12. To study methods of preparation of compost by using Indore and Bangalore method.
13. To study vermicomposting of farm/other solid waste.
14. To Study factors influencing on composting.

References:

1) Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed –2004.
2) Environmental Science; by-Santra SC; Central Publ. NewDelhi
3) Fundamentals of Ecology: E. P. Odum
4) Modern concepts in Ecology: H. D. Kumar
5) Gary K Meffe and Ronald Carroll C (1994) Principles of Conservation Biology.
6) Sinauer Associates Inc., Massachusetts.
7) Groombridge B (Ed.) (1992) Global Biodiversity Status of the Earths Living
8) Resources. Chapman & Hall, London. • IUCN (1992) Global Biodiversity and Strategy.
9) Sharma PD (2000) Ecology and Environment. Rastogi Publications, Meerut, • India.
10) Singh MP, Singh BS and Soma S. Dey (2004) Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.
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14) Raymond F Dasmann, Environmental Conservation, John Wiley (1984).
15) Kato, M. The Biology of Biodiversity, (1999), Springer Verlag, Tokyo.
16) Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and Protected areas, (2002). Agrobios, India.
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Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Conserving wildlife biology requires a thorough understanding of biological processes, species interactions, and ecological principles. This outcome contributes to students' comprehensive knowledge of wildlife and ecosystems.

CO4: Identifying key components of ecosystems through field observations (flora, fauna, and abiotic factors) further develops students' understanding of the complex relationships in ecosystems, supporting their comprehensive knowledge of biology and ecology.

PO2: Practical, Professional, and Procedural Knowledge

CO2: Gaining expertise in GIS mapping and remote sensing provides practical, professional knowledge and procedural skills that are widely used in ecological studies and wildlife conservation.

CO5 & CO7: Developing and implementing strategies for managing invasive species require practical, professional knowledge of ecosystem management techniques, which students will apply in real-world conservation scenarios.

PO3: Entrepreneurial Mindset and Knowledge

CO2: The skills acquired in GIS mapping and remote sensing can lead to entrepreneurial ventures in environmental consulting, data analysis for conservation, and ecological mapping services.

CO5: Developing strategies for invasive species management and control encourages students to think entrepreneurially about innovative approaches and solutions to environmental challenges, such as creating management plans or developing new technologies for biodiversity protection.

PO4: Specialized Skills and Competencies

CO3: Data analysis for biological experiments helps students develop specialized analytical skills, enabling them to interpret biological data, a critical competence in scientific research and conservation.

CO6: Analyzing different statistical models strengthens students' competencies in data-driven analysis and enhances their ability to evaluate biological experiments and research outcomes.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO5 & CO7: Developing strategies to manage invasive species requires students to apply problem-solving and analytical reasoning in identifying ecological threats, assessing impacts, and implementing solutions to manage or eradicate invasive species.
CO6: Analyzing statistical models encourages students to develop the ability to critically assess data and apply analytical thinking to biological research, which is crucial for solving ecological problems.

PO6: Communication Skills and Collaboration
CO1: Communicating the significance of wildlife conservation and the importance of preserving biological diversity requires strong communication skills to engage with stakeholders, including conservation organizations, policymakers, and the public.
CO4: Field observations of ecosystems (flora, fauna, and abiotic factors) necessitate the ability to clearly communicate findings, whether through reports, presentations, or collaborative discussions within teams of ecologists or conservationists.

PO7: Research-related Skills
CO3: Data analysis for biological experiments directly contributes to the development of research skills, as students must be able to design, analyze, and interpret biological experiments to understand ecological phenomena.
CO6: Analyzing different statistical models requires students to apply research-related skills in assessing data, making informed conclusions, and contributing to the scientific community.

PO8: Learning How to Learn Skills
CO5 & CO7: Developing and implementing strategies for managing invasive species encourages students to independently learn new methodologies and adapt to evolving conservation practices, fostering a continuous learning mindset.
CO6: Analyzing different statistical models promotes self-directed learning in statistics and data interpretation, preparing students for ongoing learning in the rapidly evolving field of data analysis.

PO9: Digital and Technological Skills
CO2: Learning GIS mapping and remote sensing equips students with essential digital skills for spatial analysis, environmental monitoring, and ecological research.
CO4: Using digital tools and technologies for field observations and ecosystem assessments enhances students' technological competencies in biological data collection and analysis.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1 & CO4: Wildlife conservation and ecosystem assessment require an understanding of diverse ecosystems and the impact of human activities on various regions, fostering empathy toward the protection of both local and global biodiversity.
CO5: Addressing invasive species management often involves working with local communities and understanding diverse cultural approaches to conservation, which promotes an inclusive spirit and respect for diverse perspectives in ecological management.

PO11: Value Inculcation and Environmental Awareness

CO1 & CO5: Engaging in wildlife conservation and invasive species management instills values related to environmental stewardship, responsibility, and the need to protect biodiversity for future generations.
CO6: Understanding the importance of statistical models in ecological studies enhances students' awareness of the critical role that data-driven decisions play in effective environmental management.

PO12: Autonomy, Responsibility, and Accountability
CO5 & CO7: Developing and implementing strategies for invasive species management encourages students to take ownership of conservation efforts and be accountable for the outcomes of their ecological interventions.
CO6: The ability to analyze statistical models requires students to be responsible for their analysis and conclusions, ensuring that the data-driven decisions they make are reliable and accountable.

PO13: Community Engagement and Service
CO1: Understanding the importance of wildlife conservation and its impact on human communities helps students become active participants in conservation efforts, contributing to the broader community's engagement in biodiversity preservation.
CO5: Working on invasive species management requires collaboration with local communities, government agencies, and other stakeholders to develop and implement solutions that benefit both the environment and local communities.

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme: B.Sc. Environmental Science

Program Code	:USENV
Class	: T.Y. B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ENV-306-MJE (A)
Course Name	: **Environmental Governance, Laws and Ethics**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1) To learn environmental governance, Laws and ethics.
2) To learn international conferences and summit for the protection and conservation of environment.
3) To learn Environmental ethics.
4) To understand concepts that are central to environmental governance, including participation, common property resources and decentralization.
5) To develop a single economic market through a standardized system of laws that applies in all member state.
6) Promoting sustainable development and safeguarding ecosystem for present and future generations.
7) Studies the moral relationship between humans and the natural environment

Course Outcomes:

By the end of the course, students will be able to:

CO1: Students understood the Acts and laws related to Environment protection.
CO2: Students aware about the fundamental duties and rights and also environmental ethics.
CO3: Students will comprehend the principles and structures of environmental governance at local, national, and international levels.
CO4: Students will demonstrate knowledge of key environmental laws, regulations, and policies, including their historical development and current status.
CO5: Students will develop research and writing skills specific to environmental law, including the ability to interpret and analyze legal documents.
CO6: Students will understand mechanisms for compliance monitoring and enforcement of environmental laws, exploring the role of regulatory agencies and legal instruments.
CO7: Students will analyze ethical considerations and dilemmas in environmental decision-making, exploring the ethical implications of various policy choices.

Topics and Learning Points

Teaching Hours

Unit-1 Environmental Governance and International Conference **10**

- Introduction, Need and necessity, Elements of environmental governance Environmental governance in India since 1972. Environmental protection and Fundamental Rights.
- Environmental International Conference: Stockholm conference, The Earth Summit 1992 – The Rio declaration on environment and development, The Earth Summit agreements. India's International Obligations, Public interest litigation.

Unit-2 Environmental Act **10**

- The Water (Prevention and Control of Pollution) Act–1974
- The Air (Prevention and Control of Pollution) Act – 1981
- Motor Vehicle Act, 1988.
- Environmental Conservation Act: The Biological Diversity Act, 2002 Forest Conservation Act, 1980.Indian Forests Act (Revised) 1982. National Forest Policy. The Environment (Protection) Act, 1986
- Scheme of labeling of environmentally friendly products (Ecomark).

Unit-3 Environmental Ethics and Ethical Challenges **10**

- Environmental Ethics: Introduction, concept. Development of environmental ethics, ethical theories applied to the environment. Environmental ethics in spirituality, fundamental concerns, relationship between people and environment.
- Ethical Challenges: The ethical dilemma, environmental ethics and population, pollution. Value options, environment and technology. Human life and its environment – The art of ethics and an ethical dilemma, Challenges of world environmental ethics.

References:

1) Computerized environmental modelling – J. Hardstay, DM Tailor & SEMetcalf
2) Computerized aided environmental management – SA Abbassi and FIKhan.
3) Environmental Governance: The Global Challege; By Lamont C. Hempel; Island Press (1996)
4) Environmental Issues in India – A Reader; By Mahesh Rangrajan; Pearson-Longman Publ.(2007)
5) Handbook of Environmental Law, Acts, Guidelines, Compliances, and Standards: Vol. I and II; by R.K. Trivedy; BS publ(2004).
6) International Environmental Law, Fairness, Effectiveness and World Order; by Elli Louka, Cambridge, (2006)
7) Global Environmental Governance: A Reform Agenda; by Adil Najam, Mihaela Papa,

and Nadaraja Tiliyab (2006), International Institute for Sustainable Development (IISD),Can

8) Environmental Governance and Regulation in India: by *Atiyah Curmally*; (Environment and Rehabilitation) India Infrastructure Report2002.

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1											2		
CO2										2			
CO3			3		2			3			2		
CO4						3							
CO5				3					2			1	2
CO6							2						
CO7	3												

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1 & CO2: Understanding environmental laws and regulations gives students comprehensive knowledge of how environmental protection is structured legally, both historically and in the present. This aligns with PO1, as students gain a broad understanding of environmental legal frameworks and their evolution.

CO3: Comprehending the principles and structures of environmental governance at local, national, and international levels expands students' understanding of governance systems, offering a well-rounded perspective on environmental law.

PO2: Practical, Professional, and Procedural Knowledge

CO6: Understanding mechanisms for compliance monitoring and enforcement of environmental laws provides students with professional knowledge of the procedures and roles of regulatory agencies. This outcome equips students with the practical skills to apply the legal frameworks in real-world contexts.

CO5: Developing research and writing skills specific to environmental law enhances students' professional competencies, preparing them to interpret, analyze, and apply legal documents and regulations in professional settings.

PO3: Entrepreneurial Mindset and Knowledge

CO3 & CO4: Comprehending the principles of environmental governance and key environmental issues can foster an entrepreneurial mindset. Students may recognize opportunities to innovate within the legal and regulatory frameworks for environmental protection, whether through advocacy, consultancy, or new policy development.

CO6: Understanding compliance mechanisms can also inspire entrepreneurial approaches to creating services or technologies that aid in monitoring and enforcing environmental laws.

PO4: Specialized Skills and Competencies

CO1 & CO4: The knowledge of environmental laws and regulations gives students specialized competencies that are essential for navigating the legal complexities of environmental protection, helping them become skilled professionals in the field.

CO5: Developing research and writing skills related to environmental law adds to students' specialized capabilities in legal analysis, interpretation, and documentation, which are crucial for work in legal practice or policy development.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO7: Analyzing ethical considerations in environmental decision-making encourages students to apply critical thinking and problem-solving abilities to ethical dilemmas within environmental law and policy, fostering analytical reasoning.

CO5: The ability to interpret and analyze legal documents in environmental law builds the capacity for applying knowledge in complex situations and solving legal problems related to environmental issues.

PO6: Communication Skills and Collaboration

CO5: The development of research and writing skills specific to environmental law enhances students' ability to communicate complex legal ideas clearly and effectively, whether through written documents or presentations.

CO7: Analyzing ethical considerations and dilemmas in environmental decision-making encourages students to collaborate with others, including stakeholders, policymakers, and communities, to address environmental issues effectively.

PO7: Research-related Skills

CO5: Developing research and writing skills specific to environmental law directly enhances students' research capabilities, teaching them to analyze legal texts, apply appropriate methodologies, and produce high-quality legal research.

CO6: Understanding compliance monitoring and enforcement mechanisms requires students to engage in research to track the effectiveness of legal instruments, identify gaps, and propose improvements in enforcement strategies.

PO8: Learning How to Learn Skills

CO3: Comprehending the principles and structures of environmental governance at local, national, and international levels encourages students to learn independently about evolving governance structures and the impact of international treaties and national laws.

CO7: Analyzing ethical dilemmas requires continuous learning, as ethical considerations in environmental law evolve with new policies, case law, and social expectations.

PO9: Digital and Technological Skills

CO6: Understanding mechanisms for compliance monitoring often involves the use of technology (e.g., digital databases, environmental monitoring tools, and legal compliance

software), equipping students with technological skills to track, manage, and enforce environmental laws.
CO5: Developing research and writing skills related to environmental law may involve using digital tools for legal research, data collection, and document management, thus enhancing students' digital competencies.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1: Awareness of environmental laws and protection efforts encourages students to recognize the importance of preserving the environment for future generations, promoting an inclusive and empathetic approach to global environmental concerns.
CO7: Analyzing ethical considerations in environmental decision-making helps students understand cultural perspectives and the need for inclusive solutions to environmental issues that respect both human rights and ecological well-being.

PO11: Value Education and Environmental Awareness
CO2: Understanding fundamental duties and rights, along with environmental ethics, directly cultivates students' values related to environmental protection, sustainability, and social responsibility.
CO7: Analyzing ethical dilemmas in environmental law and policy promotes value inculcation by encouraging students to consider the broader environmental and societal impacts of legal decisions, fostering awareness of ecological and ethical responsibility.

PO12: Autonomy, Responsibility, and Accountability
CO6: Understanding compliance monitoring and enforcement mechanisms in environmental law fosters autonomy and responsibility, as students are prepared to make independent decisions in their professional roles, ensuring accountability in environmental governance.
CO7: Analyzing ethical considerations in environmental decision-making requires students to take responsibility for their ethical stance and decisions, aligning with the need for accountability in addressing complex environmental challenges.

PO13: Collaboration, Engagement and Service
CO3 & CO4: Comprehending environmental governance at various levels and understanding key environmental laws encourage students to engage with communities and participate in policy advocacy, contributing to public awareness and service.
CO5: Research and writing about environmental law can encourage students to communicate complex legal issues to diverse audiences, fostering community engagement on environmental issues and policy.

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Environmental Science
Program Code	:USENV
Class	: T.Y.B.Sc.
Semester	: V
Course Type	:Major Mandatory (Theory)
Course Code	: ENV-306-MJE (B)
Course Name	: **Environmental Biotechnology**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1) To learn composting, vermicomposting and biofuels.
2) To learn genetically modified organisms and their release criteria.
3) To learn bioremediation and energy production process.
4) To differentiate the organisms by its cell structure.
5) To explain the arrangement of Genes and their interaction.
6) To describe the influence of environment on gene expression.
1) To know Components of the Cell and their division

Course Outcomes:

By the end of the course, students will be able to:

CO1: Students understood composting, Vermicomposting and biofuel.

CO2: Students understanding biotechnology and it's used to control the environmental pollution.

CO3: Students will gain a foundational understanding of biotechnological principles and applications in the context of environmental science.

CO4: Students will learn and apply various bioremediation techniques to address environmental pollution, including the use of microorganisms to degrade pollutants.

CO5: Students will understand and apply biotechnological methods for the treatment of various types of wastes, with an emphasis on recovering valuable resources.

CO6: Students will learn about the microbial processes involved in biogas production, anaerobic digestion, and other bioenergy production methods using organic waste.

CO7: Students will understand the regulatory frameworks governing environmental biotechnology and consider ethical aspects in the application of biotechnological solutions

Topics and Learning Points

Unit-1Intr of Environmental Biotechnology **Teaching Hours**

- Env l Biotechnology: Meaning, necessity and scope, history of environmental bio , objectives of environmental biotechnology. **8**

Unit-2 Mic echnology

- Eco ciation of microbes – biotic and abiotic environment Collection, Isolation, Enr microbesλ Nutrient media and growth conditions required for microbes,λ Co plications in Environment Science . **8**

Unit-3 Pla nology

- Intr o Plant biotechnology/ Agriculture **8**
- bio Introduction to genetically modified plants and its application Micro-pro
- Bio s- and Bio-pesticides: types, role

Unit-4 Co echnology

- Co rocess/Formulation **6**
- Prin nique/Mode of action
- Ver ing

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Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1 & CO3: Understanding composting, vermicomposting, biofuels, and biotechnological principles provides students with comprehensive knowledge of environmental science, waste management, and sustainable energy solutions. This aligns with PO1 as students gain a broad understanding of biotechnological applications in environmental contexts.

CO7: Understanding regulatory frameworks governing environmental biotechnology further

enhances ... ...omprehensive knowledge of the legal, ethical, and policy aspects of biotechnol... ...ions.

PO2: Prac... ...fessional, and Procedural Knowledge
CO4 & C... ...bility to apply bioremediation techniques and biotechnological methods for waste treatm... ...onstrates practical knowledge and professional competencies. Students gain procedural k... ...e in using biotechnology for pollution control and resource recovery, a crucial skill in envi... ...biotechnology.
CO6: Lear... ...bial processes for biogas production and anaerobic digestion equips students with profe... ...lls and the ability to apply these processes in real-world scenarios, demonstrat... ...al understanding of bioenergy production.

PO3: Entre... ...l Mindset and Knowledge
CO2: Und... ... biotechnology's potential to control environmental pollution encourages students to ... ...tively about new ventures or solutions that can address environmental challenges, ...n entrepreneurial mindset.
CO1 & ... ...posting, vermicomposting, and waste treatment methods can inspire entreprenc... ...lated to sustainable waste management practices, such as starting a business that special... ...e recycling or biofuel production.

PO4: Speci... ...ls and Competencies
CO3 & C... ...ing foundational knowledge of biotechnological principles and applying bioremedi... ...ques contribute to specialized skills in biotechnology, environmental science, and polluti...
CO5: Ap... ...echnological methods for waste treatment and resource recovery adds specialized ... ...ies in bioprocesses and waste management solutions, preparing students for careers in b... ...y and environmental engineering.

PO5: Cap... ...plication, Problem-Solving, and Analytical Reasoning
CO4 & C... ...ying bioremediation techniques and biotechnological methods for waste treatment ... ...tudents' ability to solve environmental problems using biotechnological solutions. ... ...thens their capacity for application and analytical reasoning in tackling pollution an... ...nagement issues.
CO6: The ... ... of microbial processes in biogas production requires students to analyze complex bi... ...rocesses and solve problems related to bioenergy production and waste utilization...

PO6: Com... ...l Skills and Collaboration
CO5 & C... ...standing biotechnological methods for waste treatment and the regulatory framework... ...g their application requires students to communicate complex ideas effectively, ...n written reports, presentations, or collaborative projects. The ability to collaborate ... ...tory agencies, environmental organizations, or industries is also crucial in the context of... ...gy applications.
CO4: Ap... ...mediation techniques in practical scenarios involves collaboration with interdisci... ...ts (e.g., environmental scientists, engineers) and requires strong communic... ...o achieve effective solutions.

PO7: Research-related Skills

CO2 & CO3: Exploring how biotechnology can control pollution and learning about biotechnological applications in environmental science enhances students' research skills in the field of environmental biotechnology.

CO5: The application of biotechnological methods for waste treatment and resource recovery requires students to engage in research, either through literature review, laboratory experiments, or fieldwork, developing their research-related skills in environmental science.

PO8: Learning How to Learn Skills

CO3 & CO7: Students' understanding of biotechnological principles, applications, and regulatory frameworks encourages them to continue learning about emerging biotechnologies, environmental issues, and ethical considerations. This aligns with PO8 by fostering an attitude of lifelong learning in environmental biotechnology.

CO6: Learning microbial processes involved in bioenergy production encourages students to explore evolving technologies and stay up to date with developments in renewable energy, further enhancing their learning ability.

PO9: Digital and Technological Skills

CO4 & CO6: The application of bioremediation techniques, biofuel production, and biogas generation involves using digital tools, computational models, and laboratory technologies to analyze data, monitor processes, and optimize biotechnological solutions.

CO7: Understanding regulatory frameworks governing environmental biotechnology often involves using digital platforms to track legal developments, industry standards, and best practices, requiring digital skills.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO7: Understanding the ethical implications of biotechnological solutions encourages students to think inclusively about the global impact of environmental technologies, considering how they affect diverse populations and ecosystems around the world.

CO4 & CO5: Bioremediation and waste management solutions, especially in developing countries, require an understanding of local cultural and economic contexts, which fosters empathy and the ability to design solutions that are culturally sensitive and inclusive.

PO11: Value Inculcation and Environmental Awareness

CO2: Understanding how biotechnology can control environmental pollution promotes a deep awareness of environmental sustainability and the ethical responsibilities associated with environmental conservation.

CO1 & CO4: Learning about composting, vermicomposting, and bioremediation encourages students to recognize the value of sustainable waste management practices and environmental protection, aligning with PO11's focus on environmental awareness and value inculcation.

PO12: Autonomy, Responsibility, and Accountability

CO7: Understanding the regulatory frameworks and ethical considerations surrounding biotechnological solutions encourages students to take responsibility for their actions and decisions, especially in the context of environmental protection.

CO5 & ... ...pplication of biotechnological methods in waste treatment and bioenergy production ... ...udents to take ownership of projects, ensuring that the technologies used are effective, sus... ...and responsible.

PO13: Co... ...**gagement and Service**

CO5: Imp... ...biotechnological methods for waste treatment, such as composting and vermicomp... ...n directly benefit local communities by providing sustainable waste managemen...

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Environmental Science
Program Code	:USENV
Class	: T.Y. B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ENV-306-MJE (C))
Course Name	: **Remote sensing, GIS and Modeling**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Provide foundational knowledge of remote sensing principles, electromagnetic spectrum, and sensor technologies.
2. Explain the interaction between electromagnetic radiation and the Earth's surface and atmosphere.
3. Develop skills in aerial photography and interpretation for analyzing terrain and surface features.
4. Introduce Geographic Information Systems (GIS), including data types, database management, and GIS software.
5. Demonstrate the use of GPS technology for data acquisition and spatial mapping.
6. Highlight real-world applications of remote sensing and GIS in geosciences, environmental management, and planning.
7. Equip students with basic statistical tools and techniques for analyzing and modeling geospatial data

Course Outcomes:

By the end of the course, students will be able to:

CO1: Define and explain the fundamental concepts of remote sensing and satellite-based observation platforms.

CO2: Analyze how electromagnetic energy interacts with Earth materials and atmospheric constituents.

CO3: Apply techniques of aerial photo interpretation to assess landforms and structures.

CO4: Utilize GIS tools to manage, analyze, and visualize spatial and non-spatial data.

CO5: Conduct basic GPS surveys and integrate GPS data into GIS platforms for mapping and analysis.

CO6: Evaluat use of remote sensing and GIS in solving real-world problems in land use, agriculture, fo and water resource management.
CO7: Apply cal methods such as hypothesis testing, correlation, regression, and analysis of variance t et geospatial data.

Topics and Learning Points

Unit I: Fund ls of Remote Sensing **Teaching Hours**

10

- Definiti nd principles of Remote Sensing
- Electro. tic (EM) spectrum
- Interact EMR with Earth's surface
- Spectra ture and sensors
- Types forms: Geostationary and Sun-synchronous Polar Orbits
- Multi scanning
- Interacti EMR with atmosphere
- Energy se mechanisms: Reflection, Absorption, Transmission, Scattering, Refract mission
- Atmosph windows

Unit II: l Photography & Geographic Information Systems (GIS) **12**

- Aerial raphy and Air Photo Interpretation
  - tric characteristics
  - resolution, overlaps, and flight planning
  - rement of height, tone, and mapping units
  - interpretation techniques
- Geogr formation Systems
  - ions and components
  - vs. vector data
  - and non-spatial data
  - ftware overview
  - urveying, data import, processing

Unit III: App s &Statistical Analysis

8

- Applic nd Case Studies in:
  - ences
  - Resource Management
  - se Planning
  - y, Agriculture, Marine & Atmospheric Studies
- Basic l Elements:
  - ng & distributions (normal, binomial, Poisson)

- Measures of central tendency, dispersion, skewness, kurtosis
- Hypothesis testing (parametric & non-parametric)
- Correlation, regression, curve fitting, ANOVA, ordination

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Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1 & CO2: Defining and explaining fundamental concepts of remote sensing and understanding the interaction of electromagnetic energy with Earth materials provides students with foundational knowledge essential to understanding geospatial data and its role in analyzing Earth's processes. These outcomes build a comprehensive knowledge of remote sensing technology, which is fundamental to geospatial sciences and environmental analysis.

CO6: Evaluating the use of remote sensing and GIS in solving real-world problems deepens students' understanding of how these technologies are applied across various fields such as agriculture, forestry, and water resource management, contributing to their broader comprehension of Earth sciences.

PO2: Practica[illegible]fessional, and Procedural Knowledge
CO3 & CO4: [illegible]ng aerial photo interpretation techniques to assess landforms and structures, and utilizing GIS [illegible]o manage, analyze, and visualize spatial and non-spatial data, helps students develop pract[illegible]lls in remote sensing and GIS, which are highly relevant in professional environmental [illegible]ement, land use planning, and spatial analysis.
CO5: Conduct[illegible]ic GPS surveys and integrating the data into GIS platforms provide students with practical, hand[illegible]kills in geospatial data collection and analysis, directly applicable in real-world scenarios like [illegible]veying, environmental monitoring, and resource management.

PO3: Entrepr[illegible]l Mindset and Knowledge
CO6: Evaluati[illegible]pplication of remote sensing and GIS in solving real-world problems encourages students to thi[illegible]t how these technologies can be used to create business solutions in areas like land use plann[illegible]riculture, or forestry. This develops an entrepreneurial mindset by encouraging students to ide[illegible]rketable opportunities in these fields.
CO4 & CO7: [illegible]se of GIS tools and statistical methods for geospatial data analysis encourages innovative thin[illegible]where students can create entrepreneurial solutions to spatial and environmental problems, esp[illegible]n industries requiring land management or resource optimization.

PO4: Specia[illegible]lls and Competencies
CO1, CO3, [illegible]: Defining fundamental concepts of remote sensing, applying aerial photo interpretation[illegible]ilizing GIS tools to manage and analyze data directly contributes to specialized skills and com[illegible]es in spatial analysis, remote sensing, and geospatial technologies.
CO5 & CO7: [illegible]ecting GPS surveys and applying statistical methods to interpret geospatial data equip studen[illegible]specialized technical competencies that are critical in fields such as geospatial technology, en[illegible]ental science, and land use planning.

PO5: Capacit[illegible]pplication, Problem-Solving, and Analytical Reasoning
CO6: Applyin[illegible]e sensing and GIS to solve real-world problems, such as land use, agriculture, or forestry, requ[illegible]ents to apply analytical reasoning and problem-solving skills to address practical challenges in e[illegible]management and environmental conservation.
CO7: The [illegible]n of statistical methods such as hypothesis testing, correlation, regression, and analysis of v[illegible]o interpret geospatial data demonstrates students' capacity to engage in problem-solving and [illegible]en analysis, a vital skill for making informed decisions in environmental and resource m[illegible]

PO6: Co[illegible]a Skills and Collaboration
CO4 & CO6: [illegible]ng GIS tools to manage and visualize spatial data and evaluating remote sensing technologi[illegible]e practical problems require effective communication skills. Students must interpret and [illegible]their findings clearly and work collaboratively with peers or professionals in interdisciplin[illegible]gs.
CO5 & C[illegible]: [illegible]pplying GPS data to GIS platforms or analyzing geospatial data using statistical methods, [illegible]ill need to collaborate, present, and communicate technical information effectively[illegible]when working with diverse teams in the field or during project presentations.

PO7: Research-related Skills

CO6 & CO7: The ability to evaluate the use of remote sensing and GIS in solving real-world problems, as well as applying statistical methods to interpret geospatial data, enhances students' research-related skills. They will be engaged in the research process of data collection, analysis, and interpretation, which are foundational to academic and applied research in environmental and geospatial sciences.

PO8: Learning How to Learn Skills

CO1 & CO4: By understanding fundamental concepts of remote sensing and learning how to use GIS tools for spatial data analysis, students are encouraged to develop the ability to learn independently. The practical skills involved in using these technologies require a continuous learning approach, keeping students updated with technological advancements.

CO5 & CO7: Applying statistical methods and conducting GPS surveys requires students to refine their learning strategies for data interpretation and geospatial technologies, developing adaptability and lifelong learning skills.

PO9: Digital and Technological Skills

CO1, CO4 & CO5: The use of remote sensing technologies, GIS tools, and GPS systems builds students' digital and technological skills, as they must become proficient in specialized software and hardware to analyze spatial data and conduct field surveys.

CO7: The application of statistical methods to analyze geospatial data further reinforces students' technical abilities in handling complex data sets and using digital tools for scientific inquiry.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO6: Evaluating how remote sensing and GIS can solve real-world problems related to land use, agriculture, and resource management encourages students to consider diverse global and local contexts. This aligns with promoting multicultural competence by understanding the varying environmental and developmental needs across different regions and cultures.

CO7: Statistical analysis of geospatial data helps students appreciate the diverse socioeconomic and environmental factors that may affect resource management and land use in different cultures, fostering empathy and a more inclusive understanding of environmental issues.

PO11: Value Inculcation and Environmental Awareness

CO6: By evaluating the use of remote sensing and GIS to address environmental problems, students gain greater environmental awareness, learning how technology can support sustainable land use, agriculture, and water resource management. This promotes values such as sustainability and ecological responsibility.

CO5 & CO7: Conducting GPS surveys and analyzing geospatial data can help students gain insights into the environmental implications of human activities. This fosters an awareness of the need for responsible and ethical decision-making in land management and resource conservation.

PO12: Autonomy, Responsibility, and Accountability

CO5 & CO7: Conducting GPS surveys and applying statistical methods to interpret data require students to take responsibility for their work, ensuring the accuracy and reliability of the data they collect. They must be accountable for the proper use of technology and adherence to scientific

methodolo[illegible]

CO6: Eva[illegible]d applying remote sensing and GIS solutions in real-world contexts requires students t[illegible]ta[illegible]itiative in solving environmental problems and managing geospatial data responsibly.

PO13: Co[illegible]**Engagement and Service**

CO6: Eva[illegible] use of remote sensing and GIS for land use, agriculture, and water resource managemen[illegible]ages students to consider the benefits of these technologies for community developma[illegible]e empowered to engage in projects that improve resource management practices, contributin[illegible]o[illegible]y to local and global communities.

CO4 & C[illegible]bility to interpret and analyze geospatial data and to apply statistical techniques can be use[illegible]unity-based environmental monitoring projects, where students can engage with stakeholde[illegible]decision-making and advocate for better resource management strategies.

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CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Environmental Science
Program Code	:USENV
Class	: T.Y. B.Sc.
Semester	: V
Course Type	: Minor (Theory)
Course Code	: ENV-311-MN
Course Name	: **Water and Soil quality**
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To introduce students to techniques for sampling polluted soil and water.
2. To impart practical knowledge of physicochemical parameters such as pH, DO, BOD, and COD in environmental samples.
3. To train students in microbiological analysis for pollution monitoring, including MPN testing.
4. To provide hands-on experience in air pollution monitoring, including SPM, SOx, and NOx.
5. To educate students about pollution control equipment and their functioning.
6. To explore the principles and applications of phytoremediation and bioremediation using microorganisms and macrophytes.
7. To familiarize students with environmental standards, pollution control labs, and safety procedures in environmental monitoring.

Course Outcomes:

After completing this course, students will be able to:

CO1: Collect and analyze soil and water samples from polluted environments

CO2: Measure and interpret key water quality parameters such as pH, DO, COD, BOD, nitrates, and phosphates.

CO3: Operate and understand the use of high-volume air samplers and other pollution-monitoring instruments.

CO4: Assess bacteriological quality of drinking water through MPN and pathogen detection techniques.

CO5: Demonstrate the use of biological indicators like macrophytes and microbes for pollution monitoring.

CO6: Apply knowledge of noise pollution parameters and health impacts in practical monitoring.

CO7: Understand and evaluate environmental pollution control technologies and their real-world applications through field visits and hands-on training

Topics and Learning Points

Unit 1 Introduction to water pollution **Teaching Hours**

- Uses of water resources sources, distribution of Water resources on Earth, Water cycle **10**
- Characteristics of Water–Physical ,Chemical and Biological
- Water chemistry
- Sewage water–its characteristic and effects
- Water pollution definition, types of water pollution based on Point and Non- point sources
- Types of water Pollution-Lake water pollution, River water pollution, Groundwater pollution, Marine water pollution with Case studies
- Water borne diseases

Unit 2 Introduction to soil pollution

- Introduction to soil and its importance in ecosystem and Agriculture **10**
- Composition of soil
- Soil profile and their formation
- Soil properties, Texture, Soil structure, fertility
- Factors influencing soil–Soil aeration, Soil temperature etc
- Soil Nutrients –pH, Lime ,Silica ,phosphorous , Total nitrogen, Total Sulphur, Micronutrients, Soluble salts, Pesticides and Environmental friendly technologies

Unit 3 Water and Soil Pollution Management

- Water quality Standards for drinking water, different uses and by different agencies **10**
- Water Treatment Process-Primary, Secondary & Tertiary treatment, nutrient removal
- Role of national and international agencies in Water health and Sanitation
- Soil Erosion & Soil Toxicology
- Solid waste disposal
- Remediation of Contaminated site
- Soil remediation techniques

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Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1		3									2		
CO2		3								2			
CO3								3			2		
CO4			3		2								
CO5						3							2
CO6				3					2			1	
CO7	3						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Identify various sources and types of water and soil pollution and explain their environmental consequences.

CO2: Analyze the physical, chemical, and biological characteristics of water and their relevance to water quality.

CO5: Describe the properties, types, and horizons of soil and their role in agricultural productivity and ecosystem balance.

PO2: P
CO3: K
pollutio
CO4: In
pollutio
CO6: A
remedi

al, and **Procedural Knowledge**
e diseases and explain the significance of case studies in
y standards and describe different water treatment processes for
methods for determining pollution levels and suggest suitable

PO3: E
CO7: A
enviro

ndset and **Knowledge**
soil and water conservation strategies and recommend sustainable
practices.

PO4: S
CO7: A
enviro

d **Competencies**
soil and water conservation strategies and recommend sustainable
practices.

PO5: C
CO2: A
releva
CO6: A
remedi

ication, **Problem-Solving, and Analytical Reasoning**
chemical, and biological characteristics of water and their
methods for determining pollution levels and suggest suitable

PO6: C
CO3: K
pollutio
CO7: A
enviro

lls and **Collaboration**
e diseases and explain the significance of case studies in
soil and water conservation strategies and recommend sustainable
practices.

PO7: E
CO6: A
remedi
CO7: A
enviro

Skills
methods for determining pollution levels and suggest suitable
soil and water conservation strategies and recommend sustainable
practices.

PO8: L
CO6: A
remedi
CO7: A
enviro

Learn Skills
methods for determining pollution levels and suggest suitable
soil and water conservation strategies and recommend sustainable
practices.

PO9: I
CO4: I
polluti
pollu

gical Skills
standards and describe different water treatment processes for
technologies involved in water treatment processes and

PO11: Value Inculcation and Environmental Awareness
CO1: Identify various sources and types of water and soil pollution and explain their environmental consequences.
CO7: Apply knowledge of soil and water conservation strategies and recommend sustainable environmental management practices.

PO12: Autonomy, Responsibility, and Accountability
CO7: Apply knowledge of soil and water conservation strategies and recommend sustainable environmental management practices.

PO13: Community Engagement and Service
CO3: Recognize water-borne diseases and explain the significance of case studies in pollution monitoring.
CO7: Apply knowledge of soil and water conservation strategies and recommend sustainable environmental management practices.

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Syllabus as per NEP 2020 for T.Y. B.Sc. (2023 Pattern)

Name of ...ce : B.Sc. Environmental Science
Program : USENV
Class : T.Y. B.Sc.
Semes(: V
Course : Minor (Practical)
Course C : ENV-312-MN
Course N : **Practical based on Water and Soil quality**
No. of C : 02
No. of T : 60

Course O

1. To imp... knowledge of physicochemical parameters such as pH, DO, BOD, and COD in ... samples
2. To tra... microbiological analysis for pollution monitoring, including MPN testing.
3. To pr... experience in air pollution monitoring, including SPM, SOx, and NOx.
4. To edu... air pollution control equipment and their functioning.
5. To exp... principles and applications of phytoremediation and bioremediation using micro... macrophytes.
6. To fam... with environmental standards, pollution control labs, and safety procedu... environmental monitoring
7. Discus... management techniques for soil and water, including conservation, remed... environmentally friendly technologies

Course O

After co... students will be able to:

CO1: ... soil and water samples from polluted environments
CO2: ... water quality parameters such as pH, DO, COD, BOD, nitrate...
CO3: ... the use of high-volume air samplers and other pollution-monit...
CO4: ... quality of drinking water through MPN and pathogen detection tech...
CO5: ... biological indicators like macrophytes and microbes for pollu...

CO6: Apply knowledge of noise pollution parameters and health impacts in practical monitoring.

CO7: Understand and evaluate environmental pollution control technologies and their real-world applications through field visits and hands-on training

Topics and Learning Points

1. Determination of pH of Water Samples – Measuring the pH of different water sources (river, lake, groundwater, sewage).
2. Estimation of Dissolved Oxygen (DO) from given water sample.
3. Analysis of Biochemical Oxygen Demand (BOD) – Measuring the oxygen demand for organic matter degradation.
4. Estimation of Chemical Oxygen Demand (COD) from water sample.
5. Turbidity Measurement of Water.
6. Chloride Estimation in Water – Testing for chloride content in different water samples.
7. Determination of Total Suspended Solids (TSS) in Water – Assessing the level of particulate matter.
8. Detection of Coliform Bacteria in Water – Using the Most Probable Number (MPN) method to check for microbial contamination.
9. Evaluating microbial diversity and activity using culture techniques.
10. Microbial Examination of soil and Water Samples – Collecting and culturing microbes from soil and water samples.
11. Determination of Alkalinity Measurement from water.
12. Determination of Total Dissolved Solids (TDS) in Water.
13. Effect of Detergents on Water Quality – Assessing pH and dissolved oxygen changes.

References:

1) Principles of Environmental Science- Cunningham & Cunningham
2) Ecology, Environment and Resource Conservation (2006): Singh J S, Singh S P, Gupta S R, Anamaya Publ, New Delhi
3) Fundamentals of Ecology (1971):E P Odum, W B Saunders Company
4) RSRamalho,1983IntroductiontoWaste water Treatment Process, Academic press, NewYork
5) Quanag, EAR, Principles of Waste water Treatment Vol I ,Biological process, National Science Development Board ,Manila, Phillipines
6) Water pollution by Dr. Anuradha Salpekar
7) Environmental pollution Analysis by S.M. Khopkar
8) Text book of Practical Chemistry by Vogel, A.I Tatchell and Furnis
9) Dean, J.R.,Jones, A.M.,Holmes, D.,Reed,R., Weyers, J.,& Jones, A.,(2011),Practical skills

in ce Hall, Harlow

10) H sis and Design–H.M Ragunath, New age International Pu

11) S mination of water and waste water – APHA (American Public H WA (American Water Works Association),WEF (Water En

12) L nt technologies–R.K. Trivedy and Siddharth Kaul

13) P P.C.Trivedi

14) A ntal pollution -B.K. Sharma and H. Kaur

15) E K.De

16) M zar,E.C.S. Chan, Noel R.Krieg.

17) Te R.Anantha narayan andC.K. Jayaram Paniker

18) S E. R. And Thompson, L.M. Oxford Press.

19) E 6th,H.D. Wiley Books.

20) S t, Plaster, Edward J., Delmar Publishers.

21) P (2Wed.) Marcel Dekker Inc., New York.5.

comes with Course Outcomes

Course Outcomes	Programme Outcomes (POs)								
	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1							2		
CO2						2			
CO3				3			2		
CO4	2								
CO5		3							2
CO6					2			1	
CO7			2						

tion for the mapping

PO1: Co
CO1 & C
compositio
environme
students t
CO6: Inte
of enviro

Understanding
lity parameters such as pH, DO, BOD, COD, and soil K) helps students gain a comprehensive understanding of nd soil quality. Understanding these parameters allows s in environmental science and their practical applications. oil quality tests enhances students' overall understanding gement, key components of the field.

PO2: Practical, Professional, and Procedural Knowledge
CO1 & CO3: Measuring and analyzing water and soil quality requires the application of practical techniques and procedures in environmental science. Mastery of laboratory techniques and scientific procedures is vital for students to be professionally proficient.
CO5: Proficiency in laboratory techniques is a crucial outcome for students, as it emphasizes procedural knowledge that can be directly applied in professional environmental monitoring and research.

PO3: Entrepreneurial Mindset and Knowledge
CO7: Recommending suitable water and soil conservation strategies based on scientific analysis encourages students to think creatively about sustainable solutions to environmental issues. This can lead to entrepreneurial ventures focused on water and soil management, promoting innovations in conservation practices.
CO4: Identifying pollution sources and assessing environmental impact develops an entrepreneurial mindset to create solutions for addressing environmental pollution, potentially inspiring sustainable businesses or services in water and soil management.

PO4: Specialized Skills and Competencies
CO1, CO3, & CO5: Understanding and applying laboratory techniques to measure water and soil quality parameters, as well as assessing microbial contamination, equips students with specialized skills in environmental monitoring. This specialized knowledge is vital in environmental research, consultancy, and policy-making.
CO6 & CO7: Analyzing data and recommending conservation strategies provide students with the technical competencies to interpret complex environmental data and apply it to real-world conservation and management issues.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1 & CO4: Measuring key water quality parameters and identifying pollution sources require students to apply their analytical skills and problem-solving abilities. Understanding how contaminants impact water and soil quality fosters the capacity to address real-world environmental challenges.
CO6: Interpreting data from quality tests strengthens analytical reasoning skills, as students need to process and evaluate results to make informed decisions about environmental management.

PO6: Communication Skills and Collaboration
CO6 & CO7: Communicating the interpretation of water and soil quality test results and recommending conservation strategies requires strong communication skills. Whether presenting data or writing reports, students must convey complex scientific findings clearly and effectively to various stakeholders.
CO4 & CO5: Collaboration may also be necessary in identifying pollution sources and performing laboratory analyses, requiring teamwork and effective communication among peers, researchers, and professionals in the field.

PO7: Research-related Skills
CO1 & CO3: Measuring water and soil quality parameters, as well as analyzing microbiological

contamin ires
aligns wit g sk
CO6 & C reti
of applied ent
environme ons

PO8: Lea H v **to**
CO2 & dent
pollution velo
address en viro
CO6 & lers
recomme egic
particularl nme

PO9: Di echn
CO6 & day'
use of di an
Students use
recomme es ba
CO1, C 5: S
GIS map mo
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PO10: M l C
CO7: Rec g w
students r di
solutions lapta
spirit.
CO4: poll
understan envi
students th
pollution imp

PO11: ca ti
CO2, C 07:
sources, erv
responsibi pply
environme ces
CO6: in
demonstr
sense of d

PO12:
CO1 &
student
interpre

ted skills in data collection, testing, and analysis. This
neting scientific research and fieldwork.
ecommending conservation strategies are key components
This fosters students' ability to engage in research-based
velopment.

microbiological contamination in water and identifying
king and learning strategies. Learning how to identify and
s encourages an ongoing learning process.
nalyzing data from water and soil quality tests and
analysis help students refine their learning methods,
contexts, fostering adaptability and continuous learning.

ls
ronmental monitoring and data analysis often involve the
s (e.g., laboratory equipment, data analysis software).
ologies to interpret water and soil quality data, and to
dings, enhancing their digital and technological skills.
tilize various digital tools (e.g., spreadsheets, databases,
recording water and soil quality, contributing to the
ronmental data management.

clusive Spirit, and Empathy
conservation strategies based on scientific analysis requires
ental contexts and communities. The ability to create
ecological and social settings demonstrates an inclusive

and assessing their environmental impact involves
gradation affects various communities. This encourages
cultural and economic implications of environmental

nental Awareness
derstanding of microbiological contamination, pollution
promotes greater environmental awareness and
owledge, they will be able to contribute to sustainable
conservation efforts.
ing conservation strategies based on that analysis
nvironmental issues and their significance, fostering a
e ethical responsibility to protect natural resources.

ccountability
ity parameters and analyzing soil composition require
ke responsibility for accurate data collection and
nducting scientific investigations and accountability in

ensuring quality and reliability in environmental studies.
CO4 & CO5: Identifying pollution sources and demonstrating proficiency in laboratory techniques require students to take ownership of their work, ensuring accurate and reliable analysis that contributes to environmental management.

PO13: Community Engagement and Service
CO7: Recommending and implementing water and soil conservation strategies based on scientific analysis directly benefits communities by addressing environmental concerns and promoting sustainable practices.
CO4: Identifying pollution sources and analyzing their impact on local communities encourages students to engage with local stakeholders and contribute to environmental service initiatives that improve community well-being.

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per NEP 2020 for T.Y. B.Sc.
023 Pattern)

Name of
Program
Class
Semes
Cours
Course
Cours

: Sc. Environmental Science
: USENV
: Y. B.Sc.

: cational Skill Course (VSC) (practical)
: V-321-VSC
: actical based on
: vironmental Microbiology

No. of
No. of

Cours

1. To
2. To
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6. To
7. To

eptic techniques and laboratory safety essential for

isolation and cultivation of environmental
ir, and waste.
ological and biochemical methods for microbial

ting microbial populations in various environmental

of microorganisms through experiments like
ator studies.
to biodegradation and waste treatment, including
on.
analytical thinking, and problem-solving skills
ta interpretation.

Course

After co

lents will be able to:

CO1: D
CO2: Is
wastew
CO3: I
CO4: O
CO5: I
Winogr

tic techniques in microbiology laboratories.
verse environments, including soil, air, and

phological and biochemical tests.
g methods such as viable count and plate techniques.
tions and succession through composting and

CO6: Evaluate the potential of microbes in bioremediation, such as plastic and dye degradation.
CO7: Effectively document, analyze, and communicate experimental results, aligning with scientific best practices.

Topics and Learning Points

1. To study laboratory Safety & Aseptic Techniques.
2. Sampling and Isolation of Microorganisms from the Environment.
3. To study Morphological Identification of Microorganisms.
4. To study Biochemical Characterization of Microbes.
5. Enumeration of Microbial Load in Environmental Samples.
6. Isolation of nitrogen-fixing bacteria (Rhizobium, Azotobacter)
7. To study Settle plate method for air sampling.
8. Identification of airborne fungi and bacteria.
9. To study microbial ecology in a mini-ecosystem: Winogradsky Column.
10. Use of algae as bioindicators in water quality.
11. Assessment of microbial load in wastewater treatment plants.
12. Monitoring of microbial succession during composting.
13. To study of soil microflora.
14. To study of water microflora.

References:

1. **Pelczar, M.J., Chan, E.C.S., & Krieg, N.R.** *Microbiology: Concepts and Applications*
2. **Cappuccino, J.G. & Welsh, C.T.** *Microbiology: A Laboratory Manual.*
3. **Aneja, K.R.** *Experiments in Microbiology, Plant Pathology and Biotechnology*
4. **Atlas, R.M. & Bartha, R.***Microbial Ecology: Fundamentals and Applications*
5. **Prescott, L.M., Harley, J.P., & Klein, D.A.** *Microbiology*
6. **Patwardhan, A.V.** *Industrial Microbiology.*
7. **Dubey, R.C. & Maheshwari, D.K.** *A Textbook of Microbiology* **Tortora, G.J., Funke, B.R., & Case, C.L.** *Microbiology: An Introduction.*
8. **Environmental Protection Agency (EPA)** – *Standard Methods for the Examination of Water and Wastewater*-Official guidelines for BOD, COD, MPN, membrane filtration tests, etc.
9. **WHO Guidelines** – *Water, Sanitation and Health*

Course Outcomes	PO
CO1	3
CO2	2
CO3	3
CO4	2
CO5	3
CO6	
CO7	

Justificat

PO1: Co
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PO3: Em
CO6: Em
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CO7: Em
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Outcomes with Course Outcomes

amme Outcomes (POs)							
PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
					2		
				2			
		3			2		
3							
							2
	2		2			1	

Understanding

afe handling and aseptic techniques, identifying microbial ecological interactions require students to have a thorough ciples, laboratory techniques, and microbial behavior in with the comprehensive knowledge required to understand fe in ecosystems.

g microbes from diverse environments, and quantifying s' knowledge of microbial diversity and ecological roles, f the science of microbiology.

ocedural Knowledge

aseptic techniques and isolating microbes from diverse ssential practical skills required for microbiological work. ues are directly applicable to professional practice in icrobiology.

ing and Winogradsky column experiments to understand p practical, hands-on skills that are essential for ecological y to document, analyze, and communicate experimental ls in research and scientific writing.

nowledge

icrobes in bioremediation, including plastic and dye urial mindset by demonstrating how microbial technology oblems. Students can explore commercial applications of ement and environmental cleanup, fostering innovative

communicating results in the context of bioremediation how research can be translated into marketable solutions entrepreneurial perspective.

PO4: Specialized Skills and Competencies

CO1, CO3 & CO4: Demonstrating aseptic techniques, identifying microbial species, and quantifying microbial populations are specialized skills fundamental to microbiology, providing students with a deep understanding of microbial techniques essential for careers in environmental science, biotechnology, and clinical microbiology.

CO6: Analyzing the potential of microbes in bioremediation of pollutants such as plastics and dyes helps students acquire specialized competencies in microbial biotechnology and environmental remediation, areas that are critical for addressing global environmental challenges.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO5 & CO6: Interpreting microbial ecological interactions and evaluating bioremediation potentials require students to apply problem-solving and analytical reasoning skills to assess complex environmental issues. These skills are essential for formulating effective strategies for waste management and ecosystem restoration.

CO2 & CO4: Isolating, culturing, and quantifying microbes in diverse environments, combined with interpreting experimental results, help students develop strong analytical reasoning skills. This is essential for practical problem-solving in microbiology and environmental research.

PO6: Communication Skills and Collaboration

CO7: Documenting, analyzing, and effectively communicating experimental results require clear and concise communication skills, both in written and oral formats. Students will learn how to present their findings in a professional manner, which is vital for collaboration with peers, researchers, or industry professionals.

CO1, CO5 & CO6: Collaborating with peers during microbiological experiments and bioremediation projects enhances teamwork and communication. Whether through sharing findings, discussing methodologies, or working together in lab settings, students will refine their ability to communicate effectively in collaborative environments.

PO7: Research-related Skills

CO5 & CO7: Interpreting microbial ecological interactions in experiments like composting and Winogradsky columns and evaluating bioremediation strategies directly engage students in research-related skills. They learn how to design, execute, and analyze experiments while adhering to scientific principles and methodologies.

CO2 & CO3: Identifying and culturing microbes from various environments, followed by quantifying populations, engages students in the research process, allowing them to practice laboratory techniques that form the basis for scientific inquiry in microbiology and environmental science.

PO8: Learning How to Learn Skills

CO2, CO4 & CO6: The process of isolating microbes, conducting quantitative analyses, and evaluating bioremediation methods encourages students to engage in self-directed learning. The complexity of the subject matter pushes students to learn independently, adapt to new experimental techniques, and stay current with the latest research and advancements in environmental microbiology.

CO1 & CO5: Mastering aseptic techniques, understanding microbial ecology, and learning

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PO9: Digi
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PO11: Va
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health and
CO2 &
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PO12: A
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PO13: C
CO6 &
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n foster continuous learning. Students will need to stay
veries in microbiology, environmental biotechnology, and

ls
umenting the bioremediation potential of microbes and
l platforms requires students to use technology effectively.
, software for data analysis, or digital communication tools,
oficiency.
nd population quantification, students may also use digital
data, enhancing their digital literacy and proficiency with

nclusive Spirit, and Empathy
robes in bioremediation can involve considering diverse
hallenges in various regions. This promotes an inclusive
solving, as students explore solutions that are applicable
nts.
interactions through diverse experiments like composting
robes contribute to sustainable practices across the world,
of environmental solutions.

mental Awareness
e composting and Winogradsky columns, students gain
tions and their role in the environment. Understanding
rtance of environmental conservation and encourages
more aware of the significance of microbes in ecosystem

tifying microbial populations, especially in polluted
vareness as students recognize the impact of human
tential of microbes in addressing these issues.

Accountability
municating experimental results demonstrates students'
rojects and their responsibility to accurately represent

icrobiological experiments, isolating microbes, and
re students to be responsible for their work, ensuring
r findings correctly, and adhere to scientific standards in

rvice
tential of microbes in environmental bioremediation,
udents gain the knowledge and skills to engage in
al environmental issues. Their work can contribute to
stainability efforts.

CO2 & CO5: The understanding of microbial ecology and its practical applications in the community, such as improving soil health and treating wastewater, helps students engage in service-oriented projects focused on local environmental improvements.

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s per NEP 2020 for T.Y. B.Sc.
2023Pattern)

Name o
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ld Project (FP)

Course

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logies and techniques used in collecting, analyzing,
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ms in different situations
ory problems in environmental hazards
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field project.
environment and its allied problems.
environment.

Cou
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ethodology.
ative methodology to solve environmental problems.
her choice, student manager will be able to choose an
clearly formulate& state a research problem.
anager will be able to compile the relevant literature
ble.
anager will be able to plan a research design including
erational designs if any.
anager will be able to compile relevant data, interpret &
plicable.
of the data collected, student manager will be able to
ble recommendations on the research problem.

CO8. Student manager will be able to create a logically coherent project report and will be able to defend his / her work in front of a panel of examiners.

Topics and Learning Points

Field Project Work

1) Identification of environmental issues related to society,
2) Compilation of data, typing, binding and submission of dissertation.
3) Writing of research paper.
4) Power point presentation based on project work.

Step of Project	Individual students Work in hours	Marks
Topic Selection/Study Design	05	05
Survey preparation/ Fieldwork	25	20
Analysis	10	05
Report writing	20	10
Oral Presentation		10
Total	60	50

Mapping of Program Outcomes with Course Outcomes

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3		2					1			1		
CO2	3		2					1			1		
CO3		3		2	2	2	2	1				1	
CO4		3		2	2	2	2	1				1	
CO5		3		2	2	2	2	1				1	
CO6		3		2	2	2	2	1				1	
CO7		3		2	2	2	2	1				1	

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding:
CO1 and CO2: Introduce students to innovative methodologies for solving environmental problems, broadening their understanding of different approaches to addressing environmental challenges.

PO2: Practical, Professional, and Procedural Knowledge:

CO3 to
knowl
manag
on data

veloping practical, professional, and procedural
process of conducting research in environmental
lems (CO3) to proposing recommendations based

PO3: E
CO1 and
entrepre
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edge:
methodologies (CO1 and CO2) can foster an
nts to think creatively and adaptively in addressing

PO4: S
CO3 to
environ
literatu

zed skills and competencies related to research in
rmulating research problems, compiling relevant
data, and proposing recommendations.

PO5:
CO3 to
reason
researc

lving, and Analytical Reasoning:
for application, problem-solving, and analytical
ss of conducting research. This involves identifying
g and analyzing data, and drawing conclusions.

PO6:
CO3 to C
with pro
proble

ion:
their research findings effectively and collaborate
l stakeholders. This includes articulating research
recommendations.

PO7:
CO3 to
resear
analyz

loping research-related skills such as formulating
ews, designing research studies, collecting and
on empirical evidence.

PO8:
CO1 a
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CO3
necess

ive methodologies, which require them to learn new

search process, helping them develop the skills
ment.

PO11:
CO1
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envir

al Awareness:
e of innovative methodologies for addressing
alues of creativity, adaptability, and innovation in

PO12:
CO3
auton
recom

tability:
rship of their research projects, demonstrating
lems, conducting studies, and proposing
sponsibility and accountability in their research

endeavors.

*****