



Anekant Education Society's
Tuljaram Chaturchand College, Baramati.

(Autonomous)

(Faculty of Science & Technology)

T.Y.B.Sc. (Environmental Science) Semester-V
For Department of Environmental Science
Tuljaram Chaturchand College, Baramati.

Choice Based Credit System Syllabus (2023 Pattern)
(As Per NEP 2020)
To be implemented from Academic Year 2024-2025

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 of Arts, Science and Commerce, Baramati
(Autonomous)**

Course Structure for T. Y. B. Sc. Environmental Science (2022 Pattern)

Class	Semester	Paper Code	Paper Title	Credit
T.Y.B.Sc.	V	USES 351	Ecosystem Management	3
		USES 352	Wildlife Biology	3
		USES 353	Geoscience	3
		USES 354	Nature Conservation	3
		USES 355	Environmental Governance, Laws and Ethics	3
		USES 356	Environmental Biotechnology	3
		USES 357	Practical based on USES 351 and USES 352	2
		USES 358	Practical based on USES 353 and USES 354	2
		USES 359	Practical based on USES 355 and USES 356	2
	VI	USES 361	Climate Change	3
		USES 362	Analytical Methods	3
		USES 363	Sustainable Development	3
		USES 364	Environmental Statistics	3
		USES 365	Environmental Safety and Risk Management	3
		USES 366	Environmental Economics and Audit	3
		USES 367	Practical based on USES 361 to USES 363	2
		USES 368	Practical based on USES 364 to USES 366	2
		USES 369	Project	2

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USES 351**
Paper: **I** Title of Paper: **Ecosystem Management**
Credit: **3** No. of lectures: 48

Course Objective:

- 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 Outcome:

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

CO1: Students understand terrestrial ecosystem and its resources.

CO2: Students understand 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.

Credit-I (16L)**Unit-1-Terrestrial Ecosystem**

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. (8L)

Unit-2- Terrestrial Community

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. (8L)

Credit –II (16L)

Unit-1- Terrestrial Ecosystem Management

Methods of terrestrial ecosystem management: remote sensing, geographical information system, ethnobotany, non wood forest (From Wood and non-wood forest) community-based forest management, traditional methods, Forest fire: reasons, effects, control measures and management Methods of vegetation sampling and data analysis: sampling approaches, quadrat methods, line and belt transect, the point frame method, vegetation classification, species association. (8L)

Unit-2-Aquatic Ecosystem

Introduction, Limnology, Aquatic environment, aquatic biota and water resources. Water and plant functioning, structure of aquatic communities. The parameters of the aquatic environment. (8L)

Credit-III (16L)

Unit-1 Types of Aquatic Ecosystem

Distribution of major aquatic ecosystems, patterns, ecotone and edge effect, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation, and mutualism. (6L)

Unit-2 Management of Aquatic Ecosystem

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. (10L)

Reference: -

1. Principles of Environmental science - Cunningham and Cunningham
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. New Delhi

6. Lillisand, 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

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Students will demonstrate an understanding of terrestrial ecosystem structure and function.

CO2: Students will demonstrate an understanding of aquatic ecosystem dynamics.

PO2: Critical Thinking and Problem solving:

CO3: Students will apply critical thinking skills to analyze the challenges associated with ecosystem conservation and restoration.

CO4: Students will develop problem-solving strategies for addressing natural and human-induced disturbances in ecosystems.

PO3: Social competence:

CO5: Students will collaborate in group projects focused on ecosystem conservation and management.

CO6: Students will communicate effectively about ecological principles and conservation strategies to diverse audiences.

PO4: Research-related skills and Scientific temper:

CO7: Students will conduct research on ecological topics, applying scientific methods to gather and analyze data.

CO4: Students will demonstrate a scientific temper by critically evaluating ecological research literature.

PO5: Trans-disciplinary knowledge:

CO4: Students will integrate knowledge from various disciplines to address complex challenges in ecosystem conservation.

PO7: Effective Citizenship and Ethics:

CO6. Students will explore the role of effective citizenship in promoting sustainable ecosystem practices.

PO9: Self directed and life- long Learning:

CO6: Students will recognize the importance of life-long learning in the dynamic field of ecology and ecosystem management.

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USES 352**
Paper : **II** Title of Paper : **Wildlife Biology**
Credit : **3** No. of lectures : 48

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

- 1) Students get information about wildlife and their various species.
- 2) Students understanding diversity of wildlife and their scope.
- 3) Students will learn to assess different types of habitats and understand the principles of habitat management to support wildlife populations.
- 4) Students will comprehend the principles of conservation biology, including the importance of genetic diversity, habitat preservation, and the role of protected areas.
- 5) 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.
- 6) Students will understand and apply ethical principles in wildlife research and management, ensuring humane treatment of animals and responsible conduct in the field.
- 7) Students will demonstrate a deep understanding of wildlife ecology, including population dynamics, community interactions, and ecosystem relationships.

Credit-I (16L)**Unit-1 Introduction**

Introduction, Concept of Wildlife Biology, Definition of Wildlife, examples of protected wildlife species (Refer to Wildlife Protection Act). (8L)

Unit-2 Outline of Diversity of major groups

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.

(8L)

Credit-II (16L)

Unit-1 Habitats of wildlife diversity

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. (8L)

Unit-2 Threats of wildlife diversity

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. (8L)

Credit-III (16L)

Unit-1 Wildlife Management Techniques

Wildlife Management Techniques: Population assessment techniques for flying insects, Birds and Mammals: Transects, Point Counts, net swipes, census from pug marks, camera trapping Diversity assessment for plants: Determination of sampling area, quadrates, transects, point centre method, Diversity Indices and its applications. UAV (Unmanned aerial vehicles), Remotely piloted aircraft. (8L)

Unit-2 Biodiversity

Reasons for biodiversity formation, contribution to adaptive evolution, land races of crop plants, conservation of genetic resources, highly productive and unique habitats, examples of wetlands and mangrove ecosystem. (8L)

Reference:-

1. Plant Diversity Hotspots in India (1997): PK Hajra and V. Mudgal; Botanical Survey of India
2. Environmental Management (2005): Bala Krishnamoorthy; Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed – 2004.
4. Environmental Science; by-Santra SC; Central Publ. New Delhi
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). Agrobios, 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
CO1				3					
CO2	3								
CO3	3	2		1	1			1	
CO4	3	2		1				1	
CO5			3						2
CO6		3	2			1	2		
CO7	3		2		1	1			1

Justification for the mapping

PO1: Disciplinary Knowledge:

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.

CO7: Students will demonstrate a deep understanding of wildlife ecology, including population dynamics, community interactions, and ecosystem relationships.

PO2: Critical Thinking and Problem solving:

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.

CO6: Students will understand and apply ethical principles in wildlife research and management, ensuring humane treatment of animals and responsible conduct in the field.

PO3: Social competence:

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.

PO4: Research-related skills and Scientific temper:

CO1: Students get information about wildlife and their various species.

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.

PO5: Trans-disciplinary knowledge:

CO3: Students will learn to assess different types of habitats and understand the principles of habitat management to support wildlife populations.

CO7: Students will demonstrate a deep understanding of wildlife ecology, including population dynamics, community interactions, and ecosystem relationships.

PO6: Personal and professional competence:

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.

PO7: Effective Citizenship and Ethics:

CO6: Students will understand and apply ethical principles in wildlife research and management, ensuring humane treatment of animals and responsible conduct in the field.

PO8: Environment and sustainability:

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.

PO9: Self directed and life- long Learning:

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.

CO7: Students will demonstrate a deep understanding of wildlife ecology, including population dynamics, community interactions, and ecosystem relationships.

Class	:	T. Y. B. Sc. (Semester - V)
Paper Code	:	USES 353
Paper: III		Title of Paper: Geosciences'
Credit: 3		No. of lectures: 48

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 Outcome:

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

- 1) Students understood origin of earth and soil weathering process.
- 2) Students understood natural hazards and disaster.
- 3) 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.
- 4) Students will analyze and interpret the principles of plate tectonics, including the movement of Earth's lithospheric plates, volcanic activity, and seismic events.
- 5) Students will identify minerals and rocks, understand their formation processes, and analyze their significance in geological contexts.
- 6) Students will understand atmospheric processes, climate patterns, and weather systems, including factors influencing climate change.
- 7) Students will study the chemical composition of Earth materials, including rocks, minerals, and fluids, and their role in geological processes.

Credit-I (16L)**Unit 1- Origin and evolution of earth.**

Introduction, Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere, Lithosphere. Concept of minerals and rocks.

Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina.

Concept of residence time and rates of natural cycles. Geophysical fields. (10L)

Unit 2- Soil Weathering

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. (10L)

Credit-II (16L)**Unit 1- Oceanography**

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law, groundwater fluctuations, land subsidence, effects of excessive use of groundwater. Pollution of groundwater resources. Ocean basins and physical structure of the ocean floor. Properties of sea water, waves and tides, ocean Currents. (10L)

Unit 2 - Conservation of Natural Resources

Introduction, Natural resource exploration and exploitation and related environmental concerns. Historical perspective of non-renewable resources.

Conservation of non-renewable resources. (9L)

Credit-III (16L)**Unit 1 - Natural Hazards and Disasters**

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. (9L)

Reference:-

- 1) Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed – 2004.
- 2) Environmental Geology: Edward A. Keller Khanke, H. 1968.
- 3) Soil Physics. McGraw Hill Publishing Co., New Delhi.
- 4) Ghildyal, B P, KP Tripathi. 1987. Soil Physics. Wiley Eastern Limited, New Delhi
- 5) Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
- 6) Environmental Science; by-Santra SC; Central Publ. New Delhi
- 7) Lutgens F. K., Tarbuck, E. J. and Tasa, D. 2008. Essentials of Geology, Prentice Hall Publishers.
- 8) Bell F. G., 1998. Environmental geology: principles and practice. Blackwell Sc.. Oxford.
- 9) Thurman, H.V. and Trujillo, A.P., 2004, Introductory Oceanography, Prentice Hall.
- 10) Randolph, J. 2004 Environmental land use planning and management, Island Press, Washington.

- 11) Strahler, A.H and Strahler A.N (2002): Modern Physical Geography, John Wiley and Sons.
- 12) Kale, V. S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman, Calcutta.
- 13) Chamley, H. and Chamley, H. 2003. Geosciences, Environment and Man Elsevier Science & Technology.
- 14) Savindra Singh (2002): Geomorphology, PrayagPustakBhawan, Allahabad.
- 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.
- 18) Physical geography by Mazid Husen.

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Students have acquired knowledge of the origin of Earth and the soil weathering process.

CO3: Students have demonstrated a comprehensive understanding of the Earth's internal structure, including the composition and properties of the Earth's crust, mantle, and core.

CO5: Students can identify minerals and rocks, understand their formation processes, and analyze their significance in geological contexts.

PO2: Critical Thinking and Problem solving:

CO4: Students have analyzed and interpreted the principles of plate tectonics, including the movement of Earth's lithospheric plates, volcanic activity, and seismic events.

CO6: Students understand atmospheric processes, climate patterns, and weather systems, including factors influencing climate change.

PO4: Research-related skills and Scientific temper:

CO3: Students have demonstrated a comprehensive understanding of the Earth's internal structure, showcasing research-related skills.

CO4: Students have analyzed and interpreted geological principles, displaying scientific temper.

PO5: Trans-disciplinary knowledge:

CO2: Students have understood natural hazards and disasters, bridging geological knowledge with broader considerations.

PO8: Environment and Sustainability:

CO6: Students understand atmospheric processes, climate patterns, and weather systems, contributing to awareness of environmental factors.

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USES 354**
Paper : **IV** Title of Paper : **Nature Conservation**
Credit : **3** No. of lectures : 48

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 for assessment and monitoring of biodiversity as well as wildlife management.
- 7) To apply knowledge to solve problems related to wildlife conservation and management.

Course Outcome:

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

- 1) Students aware about nature conservation methods and their international efforts.
- 2) Students understood objectives and challenges of nature conservation.
- 3) Students will understand the ecological principles that govern ecosystems and develop skills in habitat management for the conservation of biodiversity.
- 4) Students will gain knowledge about the conservation of wildlife species, including endangered and threatened species, and understand the principles of captive breeding and reintroduction.
- 5) Students will understand the legal and policy frameworks related to nature conservation at local, national, and international levels.
- 6) Students will learn principles and practices related to the establishment, design, and management of protected areas for conservation purposes.
- 7) Students will explore ethical considerations in conservation decision-making, addressing issues such as the trade-off between conservation goals and human development.

Credit-I (16L)**Unit 1- Introduction**

Concept of Nature Conservation; Convention on Biological Diversity (CBD), Protected Area Network (PAN) in India, Details of PAN in Maharashtra state. (8L)

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. (8L)

Credit-II (16L)**Unit 1 Awareness about Conservation**

Awareness about Conservation: Need, Importance, Methods, Examples National Initiatives for Nature Conservation Ecotourism: Objectives, Principles, Merits, Disadvantages, Limitations, Challenges, Examples. (8L)

Unit-2 International efforts for Conservation

International efforts for Conservation: Role of IUCN, WWF and other Prominent organizations, Role of Governments, International Conventions and Protocols .Role of NGOs, Green Peace, International Whaling Mission, BNHS, Reindeers, Tigers, Crocodile farms, Examples of extreme activism, and practical sustainable efforts. (8L)

Credit-III**Unit 1- Wildlife Law and Administration**

Wildlife Law and Administration: Wildlife Protection Act, its merits and limitations .State Symbols (Animals and Plants) ,Administrative Setup: MoEF, Climate Change Central and State Pollution Control Boards, Interface between administration and NGO's. Personalities, Institutions, Groups & NGO working for environmental conservation. (8L)

Unit 2- Nature Conservation Challenges

Objectives of Nature Conservation, Challenges (Social, Political, Economical) (8L)

Reference:-

- 1) Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed – 2004.
- 2) Environmental Science; by-Santra SC; Central Publ. New Delhi
- 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.
- 11) Virchow D (1998) Conservation and Genetic Resources, Springer-Verlag, Berlin.
- 12) Singh B, Social Forestry for Rural Development, Anmol Publishers, New Delhi (1992).
- 13) Murthy J.V.S., Watershed Management in India, (1994).
- 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.
- 17) Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice, (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
CO1	3		3		2	2		3	
CO2	3	2							2
CO3	2	2		3					3
CO4	3	3		3					
CO5					2				
CO6						2			
CO7			3				3		

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Students are knowledgeable about methods for nature conservation and their international initiatives.

CO2: Students have a comprehensive understanding of the objectives and challenges associated with nature conservation.

CO3: Students comprehend the ecological principles governing ecosystems and possess skills in habitat management for biodiversity conservation.

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

PO2: Critical Thinking and Problem solving:

CO2: Students critically analyze the objectives and challenges associated with nature conservation.

CO3: Students engage in critical thinking about ecological principles governing ecosystems and apply problem-solving skills in habitat management for biodiversity conservation.

CO4: Students critically assess principles of captive breeding and reintroduction for wildlife conservation.

PO3: Social competence:

CO1: Students are socially aware of nature conservation methods and international efforts.

CO7: Students explore the social and ethical dimensions of conservation decision-making, considering trade-offs between conservation goals and human development.

PO4: Research-related skills and Scientific temper

CO3: Students develop research-related skills in understanding ecological principles governing ecosystems and habitat management for biodiversity conservation.

CO4: Students cultivate a scientific temper in acquiring knowledge about wildlife conservation, captive breeding, and reintroduction principles.

PO5: Trans-disciplinary knowledge:

CO1: Students integrate trans-disciplinary knowledge by being aware of international nature conservation efforts.

CO5: Students understand the legal and policy frameworks related to nature conservation, fostering trans-disciplinary awareness.

PO6: Personal and professional competence:

CO1: Students enhance personal and professional competence by being aware of nature conservation methods and international efforts.

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

PO7: Effective Citizenship and Ethics:

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

PO8: Environment and Sustainability:

CO1: Students advocate for nature conservation methods and international efforts as part of environmental sustainability.

PO9: Self-directed and Life-long learning

CO2: Students engage in self-directed learning by understanding the objectives and challenges of nature conservation.

CO3: Students continue lifelong learning by understanding ecological principles and habitat management for biodiversity conservation.

Class	:	T. Y. B. Sc. (Semester - V)
Paper Code	:	USES 355
Paper: V		Title of Paper: Environmental Governance, Laws and Ethics
Credit: 3		No. of lectures: 48

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:**

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

Credit-I (16L)**Unit-1 Environmental Governance**

Introduction, Need and necessity, Elements of environmental governance Environmental governance in India since 1972. Environmental protection and Fundamental Rights. (8L)

Unit-2 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.

(8L)

Credit-II (16L)**Unit-1 Environmental Act**

The Water (Prevention and Control of Pollution) Act – 1974

The Air (Prevention and Control of Pollution) Act – 1981

The public liability Insurance Act, 1991

The National Environmental Tribunal Act,

Motor Vehicle Act, 1988.

(8L)

Unit-2 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 labelling of environmentally friendly products (Ecomark) .

(8L)

Credit-III (16L)**Unit-1 Environmental Ethics**

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.

(8L)

Unit-2 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.

(8L)

Reference:-

- 1) Computerized environmental modelling – J. Hardstay, DM Taylor & SE Metcalf
- 2) Computerized aided environmental management – SA Abbassi and FI Khan.
- 3) Environmental Governance: The Global Challenge; 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 Nadaa Taiyab (2006), International Institute for Sustainable Development (IISD), Canada
 - 8) Environmental Governance and Regulation in India: by *Atiyah Curmally*; (Environment and Rehabilitation) India Infrastructure Report 2002.

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Demonstrate a comprehensive understanding of Acts and laws related to environmental protection.

PO2: Critical Thinking and Problem solving:

CO2: Develop critical thinking by being informed about fundamental duties and rights, along with environmental ethics.

CO7: Analyze ethical considerations and dilemmas in environmental decision-making, exploring the ethical implications of various policy choices.

PO3: Social competence:

CO3: Comprehend the principles and structures of environmental governance at local, national, and international levels.

PO4: Research-related skills and Scientific temper

CO4: Demonstrate knowledge of key environmental laws, regulations, and policies, including their historical development and current status.

CO5: Develop research and writing skills specific to environmental law, including the ability to interpret and analyze legal documents.

PO5: Trans-disciplinary knowledge:

CO4: Demonstrate knowledge of key environmental laws, regulations, and policies, which requires an understanding of various disciplines.

PO6: Personal and professional competence:

CO6: Understand mechanisms for compliance monitoring and enforcement of environmental laws, exploring the role of regulatory agencies and legal instruments.

PO7: Effective Citizenship and Ethics:

CO2: Foster awareness about the fundamental duties and rights, including environmental ethics.

CO7: Analyze ethical considerations and dilemmas in environmental decision-making, exploring the ethical implications of various policy choices.

PO8: Environment and Sustainability:

CO1: Ensure students understand Acts and laws related to environmental protection, fostering environmental awareness.

CO3: Comprehend the principles and structures of environmental governance for sustainable practices.

PO9: Self-directed and Life-long learning

CO2: Foster awareness about the fundamental duties and rights, including environmental ethics, promoting a sense of life-long learning.

CO4: Demonstrate knowledge of key environmental laws, regulations, and policies, encouraging self-directed learning in the legal aspects of environmental protection.

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USES 356**
Paper : **VI** Title of Paper : **Environmental Biotechnology**
Credit : **3** No. of lectures : 48

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.
- 7) To know Components of the Cell and their division.

Course Outcomes:

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

- 1) Students understood composting, Vermicomposting and biofuel.
- 2) Students understanding biotechnology and it's used to control the environmental pollution.
- 3) Students will gain a foundational understanding of biotechnological principles and applications in the context of environmental science.
- 4) Students will learn and apply various bioremediation techniques to address environmental pollution, including the use of microorganisms to degrade pollutants.
- 5) Students will understand and apply biotechnological methods for the treatment of various types of wastes, with an emphasis on recovering valuable resources.
- 6) Students will learn about the microbial processes involved in biogas production, anaerobic digestion, and other bioenergy production methods using organic waste.
- 7) Students will understand the regulatory frameworks governing environmental biotechnology and consider ethical aspects in the application of biotechnological solutions.

Credit-I (16L)**Unit-1 Introduction**

Environmental Biotechnology: Meaning, necessity and scope, history of environmental biotechnology, objectives of environmental biotechnology. (8L)

Unit-2 Vermicomposting and Biofuels

Composting, Vermicomposting and Biofuels—Composting technology, Design aspect, composting process, Temp. Trend I and influencing factors, Vermicomposting—Earthworm life cycle, chemical characteristic of vermicompost, Operating vermicompost, Biofuels—Alternative to non fossil energy resources, Biological energy resources (8L)

Credit-II (16L)**Unit-1 GMO's in the environment**

GMO's in the environment—Risk of GMO's, Risk assessment management (Need and Importance), Directive principles for GMO's. Measures, Deliberate release, and release criteria. Biosafety—Cartagena Protocol, Biosafety regulation. (8L)

Unit-2 Bioremediation

Bioremediation—Principles, factors responsible, microbial population for bioremediation, Environmental variation in field, Enzymatic – biodegradative pathway, Genetic Engineering Approach, Bioremediation strategies; Phytoremediation—Metal and Organic Phytoremediation, need for Research and development. (8L)

Credit-III (16L)**Unit-1 Biomethanation**

Biomethanation—Anaerobic treatment for gas generation, microbiology and biochemistry, factors affecting, Problems in Biomethanation, Design of digester, Biomethanation in industries, Potential of Biomethanation from MSW, Merits of Biomethanation from MSW and Biomass gasification, Medical and hospital Waste. (8L)

Unit-2 Energy Production

Combustion of biomass, Biogas, Biodiesel, Ethanol and hydrogen. Energy production from biomass - biogas, ethanol, hydrogen Biotechnology application of bioleaching. (8L)

Reference:-

- 1) Environmental Biotechnology-Dr. M. Jay
- 2) Environmental Biotechnology -M.H. Fulekar; Oxford & IBH Publ., (2005)
- 3) Environmental Biotechnology -Alan Sagg
- 4) Environmental Biotechnology -Rajendran Gunasekaran
- 5) Environmental Biotechnology -Indu Shekar Thakur
- 6) Tade, RL 1995. Soil Microbiology. John Wiley and sons, New York. p.398.
- 7) Agrawal, KC 1996. Environmental Biology. Agro-botanical Publishers – New Delhi.
- 8) Trivedi, PR and R. Gundeep, 1992. Environmental Ecology. Akashdeep Publishing House, New Delhi.
- 9) Jogdand, SN 1995. Environmental Biotechnology. Himalaya Publishing House, Mumbai.
- 10) Crawford, RL and DL Crawford. 1996. Bioremediation - Principles and Applications. Cambridge University Press, London.
- 11) Unsworth, MH and DP Ormrod, 1992. Effects of Gaseous Air Pollution in Agriculture and Horticulture. Butterworth Scientific. p.532.

- 12) Lepp, NW, Effects of Heavy Metal Pollution on Plants. p.257.
- 13) Britton, G. 1994. Waste Water Treatment Technology. John Wiley and Sons, NY
- 14) RS Ramalho.1983. Introduction to Waste Water Treatment Process. Academic press. Newyork.
- 15) Qunag, EAR, Principles of Waste Water Treatment Vol.I Biological Process. National Science Development Board, Manila, Phillipines.
- 16) Anonymous, 1991. The Biocycle Guide to the Art and Science of Composting. The JG Press Inc., Pennsylvania. p.270
- 17) Epstein .E, 1997. The Science of Composting. Technomic publishing co inc., Pennsylvania. p.487
- 18) Dirk van Elsas, J., T.Trevors and MH Wellington, 1998. Modern Soil Microbiology.
- 19) Gasser, J.K.R. 1985. Composting of Agricultural and other Wastes. Elsevier Applied Science Publishers, New York
- 20) Gaur, AC; 1992. Organic Recycling. Indian Council of Agricultural Research Publication
- 21) Crawford.,R.L.and D.L.Crawford. 1996. Bioremediation: Principles and Applications. Cambridge University Press, Cambride.p.399.
- 22) Cook R.J. and K.F.Baker. 1983. The Nature and Practice of Biological Control of Plant Pathogens. American Phytopathological Society.p.539.
- 23) Glick,BR and Jack J Pasternak. 1994. Molecular Biotechnology: Principles and Applications of Recombinant DNA- Chapter-10 Bioremediation and Biomass Utilization.
- 24) Hinchee, R. 1994. Air Sparging for Site Remediation. Baco Ratan, Lewis Publishers.
- 25) National Research Council, Water Science and Technology Board 1993. In situ Bioremediation: When does it work? National Academy Press, Washington

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Students have demonstrated proficiency in composting, vermicomposting, and biofuel processes.

CO2: Students possess a comprehensive understanding of biotechnology and its applications in controlling environmental pollution.

CO3: Students have acquired a foundational understanding of biotechnological principles applied in environmental science.

PO2: Critical Thinking and Problem solving:

CO4: Students have developed critical thinking skills through learning and applying various bioremediation techniques for environmental pollution.

CO5: Students can analyze and apply biotechnological methods for waste treatment, emphasizing resource recovery.

PO3: Social competence:

CO7: Students understand the regulatory frameworks governing environmental biotechnology and consider ethical aspects in its application.

PO4: Research-related skills and Scientific temper

CO3: Students have gained a foundational understanding of biotechnological principles, fostering research-related skills and scientific temper.

CO4: Students have learned and applied various bioremediation techniques, demonstrating research-related skills and a scientific temper.

PO5: Trans-disciplinary knowledge:

CO2: Students comprehend biotechnology and its diverse applications in addressing environmental pollution, fostering trans-disciplinary knowledge.

CO6: Students learn about microbial processes in biogas production, anaerobic digestion, and bioenergy production from organic waste, promoting trans-disciplinary insights.

PO6: Personal and professional competence:

CO1: Students' understanding of composting, vermicomposting, and biofuel contributes to their personal and professional competence.

CO7: Consideration of regulatory frameworks and ethical aspects in environmental biotechnology enhances personal and professional competence.

PO7: Effective Citizenship and Ethics:

CO7: Understanding regulatory frameworks and ethical considerations in applying biotechnological solutions fosters effective citizenship and ethical awareness.

PO8: Environment and Sustainability:

CO5: Students understanding and applying biotechnological methods for waste treatment aligns with environmental sustainability goals.

PO9: Self-directed and Life-long learning

CO2: Students' exploration of biotechnology and its applications supports self-directed learning.

CO6: Learning about microbial processes in bioenergy production encourages a life-long learning approach.

Class: **T. Y. B. Sc. Practical-I (Based on Semester – V Theory Papers)**

Paper Code: **USES 357**

Title of Paper: **Practical based on USES 351 and USES 352**

Credit: 2

No. of Practicals: 12

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 Outcome:

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.

Practical based on USES 351-Ecosystem Management

1. Study of Flora of an urban terrestrial ecosystem/herbarium (Field practical)...2P
2. Study of primary productivity from grassland community....1P
3. Study of species interaction from forest area....1P
4. Study of vegetation by Belt/Line method....1P
5. Webseries study of invasive species in agricultural ecosystem...1P

Practical based on USES 352-Wildlife biology

6. Study of Fauna of an urban terrestrial ecosystem(Field practical)...1P

7. Quantitative analysis of phytoplanktons and determination of percent composition lockey's drop count method....1P
8. To calculate Shannon, Simpson, Sorenson's coefficient index....2P

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Contribute to the conservation of wildlife biology.

CO3: Analyze data to conclude the significance of biological experiments.

CO4: Demonstrate the ability to identify key components of ecosystems through field observations.

PO2: Critical Thinking and Problem solving:

CO6: Apply critical thinking skills to analyze different statistical models.

CO7: Develop and implement strategies for the identification, control, and management of invasive species within an ecosystem.

PO3: Social competence:

CO4: Collaborate with peers in field observations and assessments of ecosystems.

PO4: Research-related skills and Scientific temper

CO3: Enhance skills in data analysis to conclude the significance of biological experiments.

CO4: Apply scientific temper to identify key components of ecosystems through field observations.

PO5: Trans-disciplinary knowledge:

CO1: Apply knowledge to contribute to the conservation of wildlife biology.

CO2: Gain skills for jobs in GIS mapping and remote sensing.

PO6: Personal and professional competence:

CO2: Develop skills for jobs in GIS mapping and remote sensing.

CO6: Apply critical thinking in analyzing different statistical models.

PO7: Effective Citizenship and Ethics:

CO1: Contribute to the ethical conservation of wildlife biology.

CO5: Develop and implement ethical strategies for the identification, control, and management of invasive species within an ecosystem.

PO8: Environment and Sustainability:

CO1: Contribute to the conservation of wildlife biology in the context of environmental sustainability.

CO5: Develop and implement strategies for the sustainable identification, control, and management of invasive species within an ecosystem.

PO9: Self-directed and Life-long learning

CO2: Acquire skills for jobs in GIS mapping and remote sensing to promote self-directed learning.

CO6: Apply critical thinking skills to engage in life-long learning through analyzing different statistical models.

Class: **T. Y. B. Sc. Practical-II (Based on Semester – V Theory Papers)**

Paper Code: **USES 358**

Title of Paper: **Practical based on USES 353 and USES 354**

Credit: 2

No. of Practicals: 10

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) To learn effects of the atmosphere on other aspects of the earth's environments and on humans.
- 5) To learn the resulting weather and climate.
- 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 Outcome:

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 develop proficiency in conducting geological fieldwork, including mapping, data collection, and observation of geological features in diverse terrains.

CO5: Students will gain a thorough understanding of the principles of composting, including the biological processes involved in decomposition and nutrient cycling.

CO6: Students will be able to set up and design composting systems, considering factors such as bin selection, size, aeration, and temperature control.

CO7: Students will understand the role of microorganisms in the composting process and learn techniques to manage and optimize microbial activity.

Practical based on USES 353-Geoscience

1. Exercise based on the lapse rate...1P
2. Draw the simple wind roses with the help of given data....1P
3. Draw the Compound wind roses with the help of given data....1P
4. Draw the climatic maps and diagram of climograph /circular graph....2P

Practical based on USES 354-Nature Conservation

5. To study methods of preparation of compost by using Indore and Bangalore method...1P
6. To study vermicomposting of farm/other solid waste...2P
7. To Study factors influencing on composting...1P
8. Continuation of use of social media for e-networking and dissemination of ideas of nature conservation...1P

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping**PO1: Disciplinary Knowledge:**

CO1: Proficiency in wildlife biology conservation, ensuring a comprehensive understanding of ecological principles.

CO3: Expertise in data analysis to conclude the significance of biological experiments.

PO2: Critical Thinking and Problem solving:

CO3: Development of critical thinking skills through expert data analysis in biological experiments.

CO4: Proficiency in conducting geological fieldwork, including mapping, data collection, and observation, requiring problem-solving skills.

PO3: Social competence:

CO5: Understanding of composting principles, fostering social competence in sustainable waste management practices.

PO4: Research-related skills and Scientific temper

CO3: Expert data analysis in biological experiments, enhancing research-related skills.

CO4: Proficiency in conducting geological fieldwork, contributing to scientific temper.

PO5: Trans-disciplinary knowledge:

CO2: Job opportunities in GIS mapping and remote sensing, showcasing trans-disciplinary knowledge in geospatial technologies.

PO6: Personal and professional competence:

CO6: Ability to set up and design composting systems, reflecting personal and professional competence in waste management practices.

CO7: Understanding the role of microorganisms in composting, showcasing competence in microbial activity management.

PO7: Effective Citizenship and Ethics:

CO1: Contribution to wildlife biology conservation, demonstrating effective citizenship in environmental stewardship.

CO7: Ethical management of microorganisms in the composting process.

PO8: Environment and Sustainability:

CO5: Thorough understanding of composting principles, contributing to environmental sustainability.

CO6: Designing composting systems with consideration for factors such as size, aeration, and temperature control, reflecting sustainability awareness.

PO9: Self-directed and Life-long learning

CO2: Job opportunities in GIS mapping and remote sensing, promoting self-directed learning in geospatial technologies.

Class: **T. Y. B. Sc. Practical-III (Based on Semester – V Theory Papers)**

Paper Code: **USES 359**

Title of Paper: **Practical based on USES 355 and USES 356**

Credit: 2 No. of Practicals: 10

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) To describe the influence of environment on gene expression.
- 5) To know Components of the Cell and their division.
- 6) Promoting sustainable development and safeguarding ecosystem for present and future generations.
- 7) Studies the moral relationship between humans and the natural environment.

Course Outcome:

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.

Practical based on USES 355-Environmental Governance, Laws and Ethics.

1. Introduction of Environmental Governance, Laws and Ethics...1P
2. Understanding process of public interest litigation through court...1P
3. Legal survey based on questionnaire to understand environmental governance...2P
4. Introduction about Central Pollution Control Board (CPCB) ..1P

Practical based on USES 356-Environmental Biotechnology

5. To isolate microorganisms from decaying matter/soil...2P
6. Identification and classification of bacteria...1P
7. Determination of H₂S from sewage sample...1P
8. Identification and classification of bacteria by gram staining technique...1P

- Visit to Biodiversity rich area / Sewage treatment plant and submit the report.

Mapping of Program Outcomes with Course Outcomes

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

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1: Identify and analyze various legal instruments related to environmental governance, encompassing international conventions, national laws, and local regulations.

CO5: Learn and apply aseptic techniques for handling microbial cultures, ensuring contamination-free experiments.

CO6: Develop proficiency in fundamental laboratory techniques such as pipetting, dilution, solution preparation, and accurate measurement.

PO2: Critical Thinking and Problem solving:

CO2: Engage with stakeholders, including local communities and industry representatives, to understand practical challenges and considerations in environmental governance.

CO3: Conduct legal research on environmental cases, analyze court decisions, and develop case studies to understand the practical implications of environmental laws.

CO4: Participate in ethical decision-making exercises, addressing dilemmas related to environmental governance and laws.

PO3: Social competence:

CO2: Engage with stakeholders, fostering an understanding of the practical challenges and considerations in environmental governance.

PO4: Research-related skills and Scientific temper

CO1: Conduct legal research on environmental cases, analyzing court decisions and developing case studies to understand the practical implications of environmental laws.

CO7: Analyze experimental data, interpret results, and present findings, fostering skills in scientific data analysis and reporting.

PO5: Trans-disciplinary knowledge:

CO1: Identify and analyze various legal instruments related to environmental governance, fostering trans-disciplinary knowledge.

PO6: Personal and professional competence:

CO4: Participate in ethical decision-making exercises, addressing dilemmas related to environmental governance and laws.

CO6: Develop proficiency in fundamental laboratory techniques, enhancing personal and professional competence.

PO7: Effective Citizenship and Ethics:

CO4: Participate in ethical decision-making exercises related to environmental governance and laws.

PO8: Environment and Sustainability:

CO1: Identify and analyze various legal instruments related to environmental governance, emphasizing environment and sustainability.

CO2: Engage with stakeholders, including local communities and industry representatives, to understand practical challenges and considerations in environmental governance.

PO9: Self-directed and Life-long learning

CO4: Conduct legal research on environmental cases, fostering self-directed learning and a commitment to lifelong learning.
