BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI-620024

B.SC. ENVIRONMENTAL SCIENCE

CHOICE BASED CREDIT SYSTEM–LEARNING OUTCOMES BASED CURRICULUM FRAME WORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2026-2027 onwards)

Sem	Part	Courses	Title	Ins. Hrs.	Credits	Exam. Hours	Maximum Marks		
							Int.	Ext.	Total
I	I	Ability Enhancement Course – I (AEC - I)	(Tamil$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – II (AEC - II)	English Course - I	6	3	3	30	70	100
	III	Core Course -1 (CC - 1)	Fundamentals of Environmental Science	4	4	3	30	70	100
		Core Practical - 1 (CP - 1)	Environmental Science Lab	4	4	3	40	60	100
		Allied Course – 1 (AC - 1)	Any one from the list	4	4	3	30	70	100
		Allied Course Practical - I (AP-I)	Any one from the list	2	**	**	**	**	**
	IV	Value Education		2	2	3	30	70	100
		Interdisciplinary Course – 1 (IDC - 1) #	One Course from Outside Department	2	2	3	30	70	100
	Total			**30**	**22**	--	--	--	**700**
II	I	Ability Enhancement Course – III (AEC - III)	(Tamil$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – IV (AEC - IV)	English Course - II	6	3	3	30	70	100
	III	Core Course- 2(CC - 2)	Concept of Ecology	4	4	3	30	70	100
		Core Practical - 2(CP - 2)	Ecology Lab	4	4	3	40	60	100
		Allied Course – 2 (AC - 2)	Any one from the list	4	4	3	30	70	100
		Allied Course Practical - I (AP-I)	Any one from the list	2	4	3	40	60	100
	IV	Skill Enhancement Course - 1(SEC - 1) ##	Naan Mudhalvan Course/SEC (List enclosed)	2	2	3	30	70	100
		Interdisciplinary Course – 2 (IDC - 2) #	One Course from Outside Department	2	2	3	30	70	100
	Total			**30**	**26**	--	--	--	**800**

III	I	Ability Enhancement Course – V(AEC - V)	(Tamil$ / Other Languages+, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – VI (AEC - VI)	English Course - III	6	3	3	30	70	100
	III	Core Course- 3(CC - 3)	Natural Resource and Biodiversity	4	4	3	30	70	100
		Core Practical - 3 (CP - 3)	Biodiversity Lab	4	4	3	40	60	100
		Allied Course – 3 (AC - 3)	Any one from the list	4	4	3	30	70	100
		Allied Course Practical - II (AP-II)	Any one from the list	2	**	**	**	**	**
	IV	Skill Enhancement Course - 2 (SEC - 2) ##	Naan Mudhalvan Course/SEC (List enclosed)	2	2	3	30	70	100
		Interdisciplinary Course – 3 (IDC - 3) $$	One Course from Outside Department	2	2	3	30	70	100
		Health & Wellness @		--	1	--			100
	Total			**30**	**23**	**--**	**--**	**--**	**800**
	I	Ability Enhancement Course – VII (AEC - VII)	(Tamil$ / Other Languages+, #)	6	3	3	30	70	100
IV	II	Ability Enhancement Course – VIII (AEC - VIII)	English Course - IV	6	3	3	30	70	100
	III	Core Course- 4(CC - 4)	Environmental Pollution	4	4	3	30	70	100
		Core Practical - 4(CP - 4)	Environmental Pollution Lab	4	4	3	40	60	100
		Allied Course – 4 (AC - 4)	Any one from the list	4	4	3	30	70	100
		Allied Course Practical - II (AP-II)	Any one from the list	2	4	3	40	60	100
	IV	Skill Enhancement Course - 3 (SEC - 3) ##	Naan Mudhalvan Course/SEC (List enclosed)	2	2	3	30	70	100
		Interdisciplinary Course – 4 (IDC - 4) $$	One Course from Outside Department	2	2	3	30	70	100
	Total			**30**	**26**	**--**	**--**	**--**	**800**
	Summer Internship / Industrial Activity during the Summer Vacation after II Year								

V	III	Core Course - 5 (CC - 5)	Environmental Microbiology	4	4	3	30	70	100
		Core Course - 6 (CC - 6)	Biostatistics and Computation	5	4	3	30	70	100
		Core Course - 7 (CC - 7)	Environmental Tools & Techniques	5	4	3	30	70	100
		Core Course - 8 (CC - 8)	Environmental Law & Techniques	5	4	3	30	70	100
		Core Practical - 5(CP - 5)	Environmental Microbiology (P)	5	4	3	40	60	100
	IV	Skill Enhancement Course - 4 (SEC - 4)	Any one from the list	2	2	3	30	70	100
		Skill Enhancement Course - 5 (SEC - 5) ##	Naan Mudhalvan Course/SEC (List enclosed)	2	2	3	30	70	100
		Introduction to Disaster Management		2	2	3	30	70	100
		Summer Internship / Industrial Activity @@	(with Viva-Voce)	--	2	--	20	80	100
	Total			**30**	**28**	--	--	--	**900**
VI	III	Core Course - 9(CC - 9)	Environmental Toxicology	4	4	3	30	70	100
		Core Course- 10(CC - 10)	Climate Change & Sustainability	5	4	3	30	70	100
		Core Course- 11(CC - 11)	Environmental Safety and Health Management	5	4	3	30	70	100
		Core Project Work(CPW) @@	Project Work (with Viva-Voce)	6	4	3	20	80	100
	IV	Value Added Course	General Studies for Competitive Examinations	2	1	--	30	70	100
		Skill Enhancement Course - 6 (SEC - 6)	Any one from the list	2	2	3	30	70	100
		Skill Enhancement Course - 7 (SEC - 7) ##	Naan Mudhalvan Course/SEC (List enclosed)	2	2	3	30	70	100
		Environmental Studies		2	2	3	30	70	100
		Gender Studies		2	1	3	30	70	100
		Extension Activities *		--	1	--	--	--	--
	Total			**30**	**25**	**--**	**--**	**--**	**900**
	Grand Total			**180**	**150**	--	**--**	**--**	**4900**

ALLIED COURSE

First Year Students	**Second Year Students**
Biology I - Theory	Chemistry I - Theory
Biology Laboratory I - Practical	Chemistry I Lab - Practical
Biology II - Theory	Chemistry II - Theory
Biology Laboratory II - Practical	Chemistry II Lab - Practical

SKILL ENHANCEMENT COURSE (SEC)			
Sl. No.	**Title of paper**	**Sl. No.**	**MANDATORY Naan Mudhalvan Scheme##**
1.	Vermicomposting technology	1.	**2nd Semester:**
2.	Aquaponics		
3.	Rainwater Harvesting	2.	**3rd Semester:**
4.	Carbon Budgeting		
5.	Circular Economy	3.	**4th Semester:**
6.	Eco friendly Products		
7.	Intellectual Property Rights	4.	**5th Semester:**
8.	Environmental Quality Assessment		**6th Semester:**

INTERDISCIPLINARY COURSE (IDC) FOR WHO HAVE OPT TAMIL AS PART-I (for other Department Students only)	
1st Semester	Environmental Education for Sustainability
2nd Semester	Environment and Health
3rd Semester	Green Auditing
4th Semester	Marine Pollution

INTERDISCIPLINARY COURSE (IDC)# FOR WHO HAVE NOT OPT TAMIL AS PART - I		
Those who have studied Tamil upto10th+2 but opt for other languages in degree	1st Semester	Special Tamil - I
	2nd Semester	Special Tamil - II
Those who have not studied Tamil in school level	1st Semester	Basic Tamil - I
	2nd Semester	Basic Tamil – II
Those students who opt for either special Tamil (or) Basic Tamil as IDCs, have to choose 2 more IDCs courses in their 3rd and 4th Semester from Outside his/her department.		

INTERDISCIPLINARY COURSE (IDC) $$ FOR NCCCADETS ONLY	
NCC Course is a Compulsory Course for the NCC Cadets in the 3rd Semester:	**NCC Course is a Compulsory Course for the NCC Cadets in the 4th Semester:**
Introduction to NCC	1. Special Subject Army **(or)** 2. Special Subject Navy **(or)** 3. Special Subject Air force
Those students who opt for NCC Courses as IDCs, have to choose 2 more IDCs courses in their 1st and 2nd Semester from Outside his/her department.	

<table>
<tr><td>$</td><td>For those who have studied Tamil upto10th+2 (Regular Stream)</td></tr>
<tr><td>+</td><td>Syllabus for other Languages should be on par with Tamil at degree level</td></tr>
<tr><td>#</td><td>Those who have studied Tamil upto 10th+2but opt for other languages in degree level under Part-I should study special Tamil and those who have not studied Tamil in the school level should study Basic Tamil in Part–IV under the Interdisciplinary Course.</td></tr>
<tr><td>**</td><td>Examination at the end of the next semester</td></tr>
<tr><td>##</td><td>Naan Mudhalvan Scheme: As per the Naan Mudhalvan Scheme instructions, 5 courses from 2nd to 6th semester should be studied under Skill Enhancement Course.</td></tr>
<tr><td>$$</td><td>NCC Course is one of the Choices in the Interdisciplinary Course.OnlytheNCCCadetsareeligibletochoosethiscourse.However,NCCCourseisaCompulsoryCoursefortheNCCCadets.</td></tr>
<tr><td>@</td><td>Health and Wellness: Assessments:

• Use self-reflective worksheets to assess their understanding
• submit the worksheets to internal audit / external audit
• Every student's activity report should be documented and the same have to be assessed by the Physical Director with Mentor. The evaluation should be for 100 marks. No examination is required.

Scheme of Evaluation:

<table>
<tr><th>Part</th><th>Description</th><th>Marks</th></tr>
<tr><td>A</td><td>Report</td><td>40</td></tr>
<tr><td>B</td><td>Attendance</td><td>20</td></tr>
<tr><td>C</td><td>Activities (Observation During Practice)</td><td>40</td></tr>
<tr><td colspan="2">Total</td><td>100</td></tr>
</table></td></tr>
<tr><td>@
@</td><td>Summer Internship / Industrial Activity

Internship will be carried our during the summer vacation after the second year. Viva-Voce will be conducted by the college and Marks shall be send to the University and the same will be included in the 5th semester Mark Statement.

Summer Internship / Industrial Activity& Project Work

Scheme of Evaluation:

<table>
<tr><th>Description</th><th>Marks</th></tr>
<tr><td>Report</td><td>80</td></tr>
<tr><td>Viva-Voce</td><td>20</td></tr>
<tr><td>Total</td><td>100</td></tr>
</table></td></tr>
<tr><td>*</td><td>Extension Activities shall be outside instruction hours.</td></tr>
</table>

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	Credits for each Course	Total Credits	Marks
1.	I	Ability Enhancement Course	4	3	12	400
2.	II	Ability Enhancement Course	4	3	12	400
3.	III	Core Course	11	4	44	1100
4.		Core Practical	5	4	20	500
5.		Allied Course (AC)	4	4	16	400
6.		Allied Course Practical (AP)	2	4	8	200
7.		Core Project Work (CPW)	1	4	4	100
8.	IV	Skill Enhancement Course (SEC)	7	2	14	700
9.		Interdisciplinary Course (IDC)	4	2	8	400
10.		Value Education	1	2	2	100
11.		Health and Wellness	1	1	1	100
12.		Introduction to Disaster Management	1	2	2	100
13.		Summer Internship / Industrial Activity	1	2	2	100
14.		Value Added Course	1	1	1	100
15.		Environmental Studies	1	2	2	100
16.		Gender Studies	1	1	1	100
17.		**EXTENSIONACTIVITIES** (NCC / NSS / SPORTS / ANTI DRUG CELL / YRC & Any Other Activities	--	1	1	--
Total			**49**	**-**	**150**	**4900**

PROGRAMME OBJECTIVES

1. Build foundational and advanced knowledge in environmental science and sustainability.
2. Develop scientific inquiry, analytical reasoning, and research aptitude.
3. Enhance practical, technical, and employability skills through laboratory and field training.
4. Promote environmental ethics, leadership, and community engagement.
5. Prepare graduates for higher education, entrepreneurship, and environmental careers.

PROGRAMME OUTCOMES

PO1	**Communication Skill:** Mandatory language courses facilitate to become proficient in communication, culturally aware, and more employable in both Indian and global contexts. Improve presentations skill, debates, and professional communication.
PO 2	**Disciplinary Knowledge:** Learn in-depth complex scientific concepts, demonstrate their ability to explain and apply their knowledge. Consistent in learning by earning extra credits in specialized courses within the science domain and enhance disciplinary knowledge.
PO 3	**Critical thinking:** Field and academic visits will help students to develop observation skills, grasping ability, collect and interpret data and propose models that will help them to understand hypotheses and conclusions.
PO 4	**Analytical Reasoning:** Through the interactions, students will develop skills of critical reading of texts, identifying gaps in knowledge, formulating scientific questions, and on will recognizing the synthesis of new ideas.
PO 5	**Scientific Reasoning:** Skill oriented courses will provide details on principles, conduct of proper calibration and use of scientific instrumentation and appropriate use of scientific techniques in experimental design
PO 6	**Self-directed Learning:** Preparation of field reports helps them to present their results and discussion in a written format that is typically required for their future professions.
PO 7	**Reflective Thinking:** All core courses with laboratory components will provide exposure to a wide range of research techniques, therein enhancing their understanding of the application of techniques in their domain.
PO 8	**Problem Solving:** Students will develop the ability to reason, apply numerical concepts, and equations in their fields of study for interpreting scientific data and drawing relevant scientific conclusions.
PO 9	**Research-related Skills:** Students undertaking a internship will have the opportunity to design, develop and execute their own research ideas in their experiments, thus expanding their knowledge of research methods and laboratory skills.
PO 10	**Lifelong Learning:** Ability to understand the gaps in knowledge and skill, adapt to technological change, engage in self-directed learning.

FIRST YEAR **CORE COURSE 1** **SEMESTER I**

FUNDAMENTALS OF ENVIRONMENTAL SCIENCE

Code: (Theory) **Credits: 4**

COURSE OBJECTIVES

- To introduce the fundamental concepts and principles of Environmental Science.
- To understand the structure and functioning of the environment and its components.
- To gain knowledge of ecosystems, biodiversity, natural resources, and environmental issues.
- To develop awareness of environmental conservation and sustainable development.
- To understand the role of humans in environmental management and protection.

UNIT – I: INTRODUCTION TO ENVIRONMENTAL SCIENCE

Environmental Science: Definition, scope, importance, and multidisciplinary nature. Components of the environment – atmosphere, hydrosphere, lithosphere, and biosphere. Structure and functions of the environment. Human-environment interactions. Concept of sustainability and sustainable development. Environmental ethics and environmental awareness.

UNIT – II: ECOSYSTEMS

Concept, structure, and functions of ecosystems. Components of ecosystems: abiotic and biotic factors. Types of ecosystems – terrestrial and aquatic ecosystems. Energy flow in ecosystems. Food chains, food webs, and ecological pyramids. Biogeochemical cycles – water cycle, carbon cycle, nitrogen cycle, and oxygen cycle.

UNIT – III: BIODIVERSITY AND ITS CONSERVATION

Definition and levels of biodiversity – genetic, species, and ecosystem diversity. Importance and values of biodiversity. Biogeographical zones of India. Threats to biodiversity. Endangered and endemic species. In-situ and ex-situ conservation methods. Protected areas – biosphere reserves, national parks, and wildlife sanctuaries.

UNIT – IV: NATURAL RESOURCES

Natural resources – classification and importance. Forest resources, water resources, mineral resources, land resources, and energy resources. Renewable and non-renewable resources. Conservation and sustainable utilization of natural resources. Environmental impacts of resource exploitation.

UNIT – V: ENVIRONMENTAL POLLUTION AND MANAGEMENT

Concept and types of pollution – air, water, soil, noise, thermal, and radioactive pollution. Sources, effects, and control measures of pollution. Solid waste management, e-waste management, and biomedical waste management. Climate change, global warming, ozone depletion, and acid rain. Environmental management and pollution control strategies.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only)

World Environment Day. Earth Day. Sustainable Development Goals (SDGs). Climate Change and Carbon Neutrality. Plastic Pollution and Microplastics. Renewable Energy Technologies. Circular Economy. Green Technologies and Waste-to-Energy Systems.

REFERENCES

1. Cunningham, W.P. and Cunningham, M.A. (2019). *Environmental Science: A Global Concern*. McGraw Hill.
2. Botkin, D.B. and Keller, E.A. (2011). *Environmental Science: Earth as a Living Planet*. John Wiley & Sons.
3. Sharma, P.D. (2020). *Ecology and Environment*. Rastogi Publications.
4. Santra, S.C. (2019). *Environmental Science*. New Central Book Agency.
5. Joseph, K. and Nagendran, R. (2004). *Essentials of Environmental Studies*. Pearson Education.

6. Purohit, S.S., Shammi, Q.J. and Agarwal, A.K. (2018). *A Textbook of Environmental Science*. Student Edition.
7. Anjaneyulu, Y. (2009). *Introduction to Environmental Science*. BSP Books.
8. Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.
9. Miller, G.T. and Spoolman, S. (2021). *Environmental Science*. Cengage Learning.
10. Rajagopalan, R. (2016). *Environmental Studies: From Crisis to Cure*. Oxford University Press.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO No.	Course Outcomes
CO1	Understand the definition, scope, and multidisciplinary nature of Environmental Science and its role in addressing global environmental challenges.
CO2	Explain the structure, components, and functioning of the environment including atmosphere, hydrosphere, lithosphere, and biosphere.
CO3	Describe the concept, structure, and types of ecosystems and analyze the energy flow through food chains, food webs, and ecological pyramids.
CO4	Explain biogeochemical cycles—water, carbon, nitrogen, and oxygen—and their significance in maintaining ecological balance.
CO5	Describe the levels of biodiversity, its ecological and economic values, and identify biogeographical zones, endemic and endangered species in India.
CO6	Analyze the causes, consequences, and conservation strategies related to biodiversity loss including in-situ and ex-situ approaches.
CO7	Classify natural resources and assess the environmental impacts of their exploitation and sustainable management strategies.
CO8	Analyze the sources, types, effects, and control measures of air, water, soil, noise, thermal, and radioactive pollution.
CO9	Evaluate the concepts of climate change, global warming, ozone depletion, acid rain, and their global and regional environmental implications.
CO10	Develop awareness and responsibility towards environmental conservation, sustainable development, and the need for environmental ethics and management.

CO-PO Mapping Matrix

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	1	1	2	2	1	1	1	2
CO2	1	**3**	2	2	2	2	2	1	1	2
CO3	1	**3**	2	2	**3**	2	2	2	1	2
CO4	1	**3**	2	**3**	**3**	2	2	2	2	2
CO5	1	**3**	2	2	**3**	2	2	1	1	2
CO6	2	**3**	**3**	2	2	2	2	2	2	**3**
CO7	1	**3**	2	2	2	2	2	2	1	2
CO8	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO9	2	**3**	**3**	**3**	**3**	2	**3**	**3**	2	**3**
CO10	**3**	**3**	2	2	2	**3**	**3**	2	2	**3**

FIRST YEAR **CORE PRACTICAL 1** **SEMESTER I**

ENVIRONMENTAL SCIENCE LAB

Code: **(Practical)** **Credits: 4**

COURSE OBJECTIVES

- To provide practical exposure to fundamental concepts of Environmental Science.
- To develop skills in environmental sampling, analysis, and interpretation of environmental data.
- To familiarize students with ecosystem components, biodiversity assessment, and environmental monitoring techniques.
- To understand environmental quality parameters and their significance in environmental management.
- To create awareness regarding environmental conservation through field-based observations and laboratory experiments.

PRACTICAL EXERCISES

1. Identification and classification of environmental components: atmosphere, hydrosphere, lithosphere, and biosphere.
2. Identification of common aquatic and terrestrial organisms and their ecological significance.
3. Preparation and submission of ten herbarium specimens with proper field notes.
4. Study of food chains, food webs, and ecological pyramids through diagrammatic representation.
5. Preparation of environmental awareness materials (posters/charts/models) on environmental issues.

REFERENCES

1. Trivedi, R.K., Goel, P.K. and Trisal, C.L. Practical Methods in Ecology and Environmental Science. Environmental Publications, Karad, 1987.
2. APHA. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington D.C.
3. Margesin, R. and Schinner, F. Manual of Soil Analysis: Monitoring and Assessing Bioremediation. Springer, 2005.
4. Odum, E.P. and Barrett, G.W. Fundamentals of Ecology. Thomson Brooks/Cole, 2005.
5. Sharma, P.D. Ecology and Environment. Rastogi Publications, Meerut.
6. Santra, S.C. Environmental Science. New Central Book Agency, Kolkata.
7. Trivedy, R.K. Handbook of Environmental Analysis. Scientific Publishers, Jodhpur.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Identify and classify major environmental components—atmosphere, hydrosphere, lithosphere, and biosphere—through direct observation and practical exercises.
CO2	Recognize and describe common aquatic and terrestrial organisms and explain their roles in ecological systems.
CO3	Prepare and document scientific herbarium specimens with accurate field notes following standard botanical practices.
CO4	Illustrate food chains, food webs, and ecological pyramids through diagrammatic representation and relate them to energy transfer in ecosystems.
CO5	Prepare environmental awareness materials such as posters, charts, and models on current environmental issues.
CO6	Develop practical skills in environmental sampling, field observation, and data recording for ecological studies.
CO7	Communicate environmental observations effectively through scientific reports and field documentation.
CO8	Apply basic ecological concepts and methods to analyze environmental data collected during laboratory and field exercises.
CO9	Demonstrate environmental responsibility and awareness through active participation in conservation-related practical activities.
CO10	Develop scientific temperament and laboratory safety practices essential for environmental science fieldwork and experimentation.

CO-PO Mapping Matrix

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	1	2	2	1	1	1	1
CO2	1	**3**	2	1	2	2	2	1	1	2
CO3	2	2	1	1	1	2	2	1	1	1
CO4	1	**3**	2	2	2	2	2	2	1	2
CO5	**3**	2	2	1	1	2	1	1	1	2
CO6	1	2	2	2	**3**	**3**	2	2	2	2
CO7	**3**	2	2	2	2	**3**	2	2	2	2
CO8	1	2	**3**	**3**	**3**	2	**3**	**3**	2	2
CO9	**3**	2	2	1	1	**3**	**3**	1	1	**3**
CO10	1	2	2	1	2	**3**	2	2	2	**3**

FIRST YEAR **CORE COURSE 2** **SEMESTER II**

CONCEPTS OF ECOLOGY

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To understand the fundamental principles and concepts of ecology and ecosystem functioning.
- To gain knowledge about the interactions between organisms and their environment.
- To study ecological processes governing populations, communities, and ecosystems.
- To understand biodiversity, ecological succession, and biogeochemical cycles.
- To appreciate the role of ecology in environmental conservation and sustainable development.

UNIT – I: INTRODUCTION TO ECOLOGY

Ecology: Definition, scope, branches, and significance; Historical development of ecology; Levels of ecological organization – organism, population, community, ecosystem, biome, and biosphere; Habitat and ecological niche; Abiotic and biotic components of ecosystems; Ecological factors and adaptations.

UNIT – II: POPULATION ECOLOGY

Population ecology: Characteristics of populations – density, natality, mortality, age structure, dispersion, and growth forms; Population growth curves (J-shaped and S-shaped); Carrying capacity; Population regulation; Population interactions – competition, predation, parasitism, mutualism, commensalism, and amensalism.

UNIT – III: COMMUNITY ECOLOGY

Community ecology: Concept and characteristics of ecological communities; Community structure and organization; Species diversity and abundance; Ecological succession – primary and secondary succession; Ecotone and edge effect; Community stability and resilience.

UNIT – IV: ECOSYSTEM ECOLOGY

Ecosystem: Structure and functions; Types of ecosystems – terrestrial and aquatic ecosystems; Energy flow in ecosystems; Food chains, food webs, and ecological pyramids; Productivity of ecosystems – primary and secondary productivity; Ecosystem services and their significance.

UNIT – V: BIODIVERSITY AND BIOGEOCHEMICAL CYCLES

Biodiversity: Concept, levels, and importance; Patterns of biodiversity distribution; Threats to biodiversity and conservation strategies; Biogeochemical cycles – water cycle, carbon cycle, nitrogen cycle, phosphorus cycle, and sulfur cycle; Ecological significance of nutrient cycling.

UNIT – VI: CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

World Biodiversity Day; Ecosystem Restoration; Climate Change and Ecosystem Resilience; Invasive Alien Species; Nature-based Solutions; Ecological Footprint; Sustainable Ecosystem Management; Citizen Science in Biodiversity Conservation.

REFERENCES

1. Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.
2. Begon, M., Townsend, C.R. and Harper, J.L. (2006). *Ecology: From Individuals to Ecosystems*. Blackwell Publishing.
3. Krebs, C.J. (2014). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson Education.
4. Smith, T.M. and Smith, R.L. (2015). *Elements of Ecology*. Pearson Education.
5. Ricklefs, R.E. and Relyea, R. (2018). *Ecology: The Economy of Nature*. W.H. Freeman.
6. Chapman, J.L. and Reiss, M.J. (1999). *Ecology: Principles and Applications*. Cambridge University Press.
7. Molles, M.C. (2019). *Ecology: Concepts and Applications*. McGraw-Hill Education.

8. Sharma, P.D. (2020). *Ecology and Environment*. Rastogi Publications.
9. Kormondy, E.J. and Brown, D.E. (2008). *Fundamentals of Human Ecology*. Pearson Education.
10. Cunningham, W.P. and Cunningham, M.A. (2020). *Environmental Science: A Global Concern*. McGraw-Hill Education.
11. Chapin III, F.S., Matson, P.A. and Vitousek, P.M. (2012). *Principles of Terrestrial Ecosystem Ecology*. Springer.
12. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environment and Resource Conservation*. Anamaya Publishers.
13. Miller, G.T. and Spoolman, S. (2018). *Living in the Environment*. Cengage Learning.
14. Verma, P.S. and Agarwal, V.K. (2019). *Environmental Biology and Ecology*. S. Chand Publications.
15. Dash, M.C. (2001). *Fundamentals of Ecology*. Tata McGraw-Hill.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the definition, scope, branches, and significance of ecology, and describe the levels of ecological organization from organism to biosphere.
CO2	Explain population characteristics such as density, natality, mortality, age structure, and growth forms including J-shaped and S-shaped growth curves.
CO3	Analyze population interactions—competition, predation, parasitism, mutualism, commensalism, and amensalism—and their ecological significance.
CO4	Describe the structure and organization of ecological communities, including species diversity, ecological succession, ecotone, edge effect, and community stability.
CO5	Explain ecosystem structure, functions, energy flow pathways, and productivity concepts including primary and secondary productivity.
CO6	Describe major terrestrial and aquatic ecosystems and evaluate the ecosystem services they provide.
CO7	Analyze the levels, patterns, and distribution of biodiversity and identify major threats to biodiversity conservation.
CO8	Explain biogeochemical cycles—water, carbon, nitrogen, phosphorus, and sulfur—and assess their ecological significance in nutrient recycling.
CO9	Apply ecological principles to address real-world environmental management and sustainable development challenges.
CO10	Evaluate emerging ecological concepts such as ecosystem restoration, climate change impacts on ecosystems, invasive species, and nature-based solutions.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	2	**3**	**3**	2	2	2	1	2
CO3	1	**3**	**3**	**3**	**3**	2	2	2	2	2
CO4	1	**3**	2	2	2	2	2	2	1	2
CO5	1	**3**	2	2	**3**	2	**3**	2	1	2
CO6	1	**3**	2	2	2	2	2	1	1	2
CO7	1	**3**	**3**	**3**	2	2	2	2	2	**3**
CO8	1	**3**	2	**3**	**3**	2	2	2	2	2
CO9	2	**3**	**3**	**3**	2	**3**	**3**	**3**	2	**3**
CO10	2	**3**	**3**	2	2	**3**	**3**	2	2	**3**

FIRST YEAR | **CORE PRACTICAL 2 ECOLOGY LAB** | **SEMESTER II**

Code: | **(Practical)** | **Credits: 4**

COURSE OBJECTIVES

- To understand fundamental ecological concepts through field and laboratory exercises.
- To familiarize students ecological observations.
- To develop skills in the identification and quantification of plants and animals in different habitats.
- To introduce ecological data collection, analysis, and interpretation.

EXPERIMENTS

1. Study of ecological factors: Measurement of temperature, light intensity, humidity, and soil moisture.
2. Identification and classification of common terrestrial plants and animals in the local environment.
3. Study of food chains and food webs in different ecosystems.
4. Determination of primary productivity using simple aquatic ecosystem models.
5. Visit to a protected area, botanical garden, zoological park, or biodiversity park and submission of a field report.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Measure and record ecological abiotic factors such as temperature, light intensity, humidity, and soil moisture using appropriate instruments.
CO2	Identify and classify common terrestrial plants and animals in the local environment using standard taxonomic references.
CO3	Construct food chains and food webs for different ecosystems and explain energy transfer mechanisms.
CO4	Determine primary productivity of simple aquatic ecosystems using standard experimental models.
CO5	Conduct field visits to protected areas or biodiversity parks and prepare detailed field reports on ecological observations.
CO6	Apply simple ecological sampling methods including quadrat and transect techniques to collect and analyze field data.
CO7	Develop skills in ecological data collection, organization, and interpretation for biodiversity and ecosystem assessment.
CO8	Understand the principles of ecosystem management through direct observation of natural habitats and ecological processes.
CO9	Demonstrate teamwork, field safety, and ethical practices during ecological fieldwork and laboratory exercises.
CO10	Relate practical ecological findings to theoretical concepts learned in the classroom for holistic understanding of ecological sciences.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	1	**3**	2	2	2	1	1
CO2	1	**3**	2	1	2	2	2	1	1	2
CO3	1	**3**	2	2	2	2	2	2	1	2
CO4	1	2	2	**3**	**3**	2	2	2	2	1
CO5	**3**	2	2	2	1	**3**	**3**	1	2	2
CO6	1	2	**3**	**3**	**3**	**3**	2	**3**	2	2
CO7	2	2	**3**	**3**	2	**3**	2	2	2	2
CO8	1	**3**	2	2	2	**3**	**3**	2	2	**3**
CO9	2	1	2	1	1	2	2	1	1	2
CO10	1	**3**	**3**	2	2	2	**3**	2	1	**3**

SECOND YEAR **CORE COURSE 3** **SEMESTER III**

NATURAL RESOURCES AND BIODIVERSITY

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To provide an understanding of the types, distribution, and utilization of natural resources.
- To introduce the concepts, values, and significance of biodiversity.
- To examine the causes and consequences of resource depletion and biodiversity loss.
- To understand the principles and practices of natural resource conservation and sustainable management.
- To develop awareness of national and global initiatives for biodiversity conservation.

UNIT – I: NATURAL RESOURCES

Natural Resources: Definition, classification, and importance; Renewable and non-renewable resources; Natural resource distribution and utilization; Resource depletion and environmental consequences; Sustainable development and resource management.

UNIT – II: FOREST, WATER, AND LAND RESOURCES

Forest Resources: Types, distribution, uses, and ecological significance; Deforestation – causes, impacts, and conservation measures.

Water Resources: Surface and groundwater resources; Water scarcity, overexploitation, and conservation techniques; Rainwater harvesting and watershed management.

Land Resources: Land use and land cover; Land degradation, desertification, and soil erosion; Soil conservation and sustainable land management practices.

UNIT – III: MINERAL, ENERGY, AND FOOD RESOURCES

Mineral Resources: Types, extraction methods, environmental impacts of mining, and conservation of minerals.

Energy Resources: Conventional and non-conventional energy resources; Renewable energy sources – solar, wind, biomass, hydropower, geothermal, and tidal energy; Energy conservation and sustainable energy management.

Food Resources: Agricultural systems, food security, sustainable agriculture, organic farming, and agroforestry.

UNIT – IV: BIODIVERSITY – CONCEPTS AND VALUES

Biodiversity: Definition, levels, and importance; Genetic diversity, species diversity, and ecosystem diversity; Patterns of biodiversity distribution; Biodiversity hotspots; Values of biodiversity – ecological, economic, social, cultural, ethical, aesthetic, and scientific values.

UNIT – V: BIODIVERSITY CONSERVATION

Threats to Biodiversity: Habitat loss, fragmentation, invasive species, pollution, overexploitation, and climate change.

Conservation of Biodiversity: In-situ and ex-situ conservation; Protected area network – biosphere reserves, national parks, wildlife sanctuaries, conservation reserves, and community reserves; Biodiversity conservation policies and legislation; Role of local communities in conservation.

UNIT – VI: CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

International Day for Biological Diversity; Kunming-Montreal Global Biodiversity Framework; Ecosystem Restoration; Nature-based Solutions; Sustainable Resource Management; Community-Based Conservation; Green Energy Transition; Biodiversity and Climate Change.

REFERENCES

1. Gadgil, M. and Guha, R. (2013). This Fissured Land: An Ecological History of India. Oxford University Press.
2. Primack, R.B. (2020). Essentials of Conservation Biology. Sinauer Associates.
3. Groom, M.J., Meffe, G.K. and Carroll, C.R. (2006). Principles of Conservation Biology. Sinauer Associates.
4. Cunningham, W.P. and Cunningham, M.A. (2020). Environmental Science: A Global Concern. McGraw-Hill Education.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environment and Resource Conservation. Anamaya Publishers.
6. Sharma, P.D. (2020). Ecology and Environment. Rastogi Publications.
7. Miller, G.T. and Spoolman, S. (2018). Living in the Environment. Cengage Learning.
8. Raven, P.H., Berg, L.R. and Hassenzahl, D.M. (2015). Environment. Wiley.
9. Convention on Biological Diversity (CBD) Documents and Reports.
10. National Biodiversity Authority, India – Publications and Guidelines.
11. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India Publications.
12. Bharucha, E. (2019). Textbook of Environmental Studies. Universities Press.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the classification, distribution, and utilization of natural resources including renewable and non-renewable types and their global significance.
CO2	Assess the environmental impacts of resource exploitation including deforestation, water scarcity, land degradation, and mineral extraction.
CO3	Describe the principles and practices of sustainable forest, water, land, mineral, and energy resource management.
CO4	Understand the concept, levels—genetic, species, ecosystem—and ecological, economic, social, cultural, and ethical values of biodiversity.
CO5	Explain biodiversity hotspots, patterns of distribution, and their significance in conservation planning at national and global levels.
CO6	Analyze major threats to biodiversity including habitat loss, fragmentation, invasive species, overexploitation, pollution, and climate change.
CO7	Evaluate in-situ and ex-situ conservation strategies and the protected area network in India including biosphere reserves, national parks, and wildlife sanctuaries.
CO8	Describe national and international biodiversity conservation policies and legislation including the Biological Diversity Act and CBD frameworks.
CO9	Assess the role of local communities, indigenous knowledge systems, and community-based conservation in sustainable resource management.
CO10	Apply knowledge of natural resources and biodiversity to promote sustainable development and participate in national and global conservation initiatives.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	**3**	**3**	2	2	2	**3**	2	2
CO3	1	**3**	2	2	**3**	2	2	2	2	**3**
CO4	1	**3**	2	2	2	2	2	1	1	2
CO5	1	**3**	2	2	2	2	2	1	1	2
CO6	1	**3**	**3**	**3**	2	2	2	2	2	**3**
CO7	1	**3**	**3**	2	2	2	2	2	1	**3**
CO8	2	**3**	2	2	2	**3**	2	1	1	2
CO9	2	2	**3**	2	2	**3**	**3**	2	2	**3**
CO10	**3**	**3**	2	2	2	**3**	**3**	2	2	**3**

SECOND YEAR	CORE PRACTICAL 3 BIODIVERSITY LAB	SEMESTER III
Code:	**(Practical)**	**Credits: 4**

COURSE OBJECTIVES

- To familiarize students with the concepts and methods of biodiversity assessment.
- To develop skills in the identification and classification of flora and fauna.
- To introduce biodiversity monitoring techniques and ecological sampling methods.
- To provide practical exposure to biodiversity conservation and field documentation.

LIST OF EXPERIMENTS

I. FLORISTIC DIVERSITY

1. Identification and classification of common plant species using taxonomic keys.
2. Assessment of plant diversity using quadrat sampling method.
3. Estimation of density, frequency, abundance, and relative dominance of plant species.

II. FAUNAL DIVERSITY

4. Assessment of insect diversity using sweep net and pitfall trap methods.
5. Bird diversity survey using line transect and point count methods.
6. Documentation of local fauna and preparation of biodiversity checklists.

III. BIODIVERSITY ASSESSMENT AND CONSERVATION

7. Calculation of Species Richness Index.
8. Calculation of Shannon–Wiener Diversity Index.
9. Calculation of Simpson's Diversity Index.
10. Field visit to a protected area, biodiversity park, botanical garden, wildlife sanctuary, or community conservation site and submission of a field report.

REFERENCES

1. Trivedi, R.K. and Goel, P.K. Practical Methods in Ecology and Environmental Science. Environmental Publications, Karad, 1987.
2. Magurran, A.E. Measuring Biological Diversity. Blackwell Publishing, 2004.
3. Southwood, T.R.E. and Henderson, P.A. Ecological Methods. Wiley-Blackwell, 2009.
4. Krebs, C.J. Ecological Methodology. Benjamin Cummings, 1999.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, 2017.
6. Primack, R.B. Essentials of Conservation Biology. Sinauer Associates, 2020.
7. Sharma, P.D. Ecology and Environment. Rastogi Publications, 2020.
8. National Biodiversity Authority (NBA), India – Biodiversity Assessment Manuals and Guidelines.
9. Zoological Survey of India (ZSI) Publications.
10. Botanical Survey of India (BSI) Publications.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Identify and classify common plant species using standard taxonomic keys and morphological characters in laboratory and field settings.
CO2	Apply the quadrat sampling method to assess plant diversity and estimate density, frequency, abundance, and relative dominance of plant species.
CO3	Assess insect diversity using sweep net and pitfall trap methods and document findings with proper scientific records.
CO4	Conduct bird diversity surveys using line transect and point count methods and prepare biodiversity checklists for local fauna.
CO5	Calculate and interpret biodiversity indices including Species Richness Index, Shannon-Wiener Diversity Index, and Simpson's Diversity Index.
CO6	Prepare herbarium specimens and biodiversity inventories following standard scientific documentation practices.
CO7	Conduct field-based biodiversity surveys in protected areas, botanical gardens, or community conservation sites and produce detailed reports.
CO8	Evaluate the biodiversity status of local ecosystems and assess conservation needs based on field observations and data analysis.
CO9	Develop practical skills in ecological sampling, data recording, and biological monitoring for biodiversity assessment.
CO10	Demonstrate scientific communication skills through preparation of biodiversity checklists, field reports, and specimen documentation.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	1	2	2	2	1	1	2
CO2	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO3	1	2	2	2	**3**	2	2	2	2	1
CO4	1	2	2	2	**3**	2	2	2	2	1
CO5	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO6	2	2	1	1	1	2	2	1	1	2
CO7	**3**	2	2	2	2	**3**	**3**	2	2	2
CO8	2	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**
CO9	1	2	**3**	**3**	**3**	**3**	2	**3**	2	2
CO10	**3**	2	2	2	2	**3**	2	1	1	2

SECOND YEAR **CORE COURSE 4** **SEMESTER IV**

ENVIRONMENTAL POLLUTION

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To provide a comprehensive understanding of environmental pollution and its impacts on ecosystems and human health.
- To introduce the sources, types, and characteristics of major environmental pollutants.
- To understand the methods of monitoring, prevention, and control of pollution.
- To familiarize students with environmental standards, regulations, and pollution management strategies.
- To develop awareness of sustainable approaches for pollution prevention and environmental protection.

UNIT – I: INTRODUCTION TO ENVIRONMENTAL POLLUTION

Environmental Pollution: Definition, concepts, types, and causes; Sources of pollution – natural and anthropogenic; Classification of pollutants; Primary and secondary pollutants; Environmental quality and environmental standards; Impacts of pollution on ecosystems and human health.

UNIT – II: AIR POLLUTION

Air Pollution: Sources, types, and effects of air pollutants; Particulate matter ($PM_{2.5}$ and PM_{10}), sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, volatile organic compounds, and greenhouse gases; Smog – classical and photochemical smog; Acid rain; Indoor air pollution; Air quality monitoring and Air Quality Index (AQI); Prevention and control of air pollution.

UNIT – III: WATER POLLUTION

Water Pollution: Sources and types of water pollutants; Physical, chemical, and biological characteristics of water pollution; Surface water and groundwater contamination; Eutrophication; Waterborne diseases; Wastewater treatment – primary, secondary, and tertiary treatment; Water quality standards and water conservation measures.

UNIT – IV: SOIL, NOISE, AND THERMAL POLLUTION

Soil Pollution: Sources, causes, impacts, and remediation methods; Agricultural chemicals and heavy metal contamination.

Noise Pollution: Sources, measurement, impacts on humans and wildlife; Noise standards and control measures.

Thermal Pollution: Sources, impacts on aquatic ecosystems, and mitigation measures.

UNIT – V: SOLID WASTE, HAZARDOUS WASTE, AND RADIOACTIVE POLLUTION

Solid Waste Management: Sources, composition, collection, segregation, transportation, and disposal methods; Municipal solid waste management.

Hazardous Waste: Characteristics, sources, treatment, and disposal.

Biomedical Waste and E-waste: Sources, impacts, and management practices.

Radioactive Pollution: Sources, effects, safety measures, and disposal of radioactive wastes.

Principles of Reduce, Reuse, Recycle, Recovery, and Circular Economy.

UNIT – VI: CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

National Clean Air Programme (NCAP); Plastic Pollution and Single-Use Plastics; Microplastics in Aquatic Ecosystems; E-Waste Management; Swachh Bharat Mission; Sustainable Waste Management; Green Technologies for Pollution Control; Environmental, Social and Governance (ESG) Practices.

REFERENCES

1. Rao, C.S. (2018). Environmental Pollution Control Engineering. New Age International Publishers.
2. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. (2017). Environmental Engineering. McGraw-Hill Education.
3. Trivedi, R.K. and Goel, P.K. (2019). Introduction to Air Pollution. Environmental Publications.
4. Cunningham, W.P. and Cunningham, M.A. (2020). Environmental Science: A Global Concern. McGraw-Hill Education.
5. Sharma, B.K. (2021). Environmental Chemistry. Goel Publishing House.
6. De, A.K. (2017). Environmental Chemistry. New Age International Publishers.
7. Manahan, S.E. (2017). Fundamentals of Environmental Chemistry. CRC Press.
8. Bharucha, E. (2019). Textbook of Environmental Studies. Universities Press.
9. Arceivala, S.J. and Asolekar, S.R. (2013). Wastewater Treatment for Pollution Control. McGraw-Hill Education.
10. Reddy, M.A. (2016). Textbook of Environmental Science and Technology. BSP Publications.
11. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India – Environmental Regulations and Reports.
12. Central Pollution Control Board (CPCB) Manuals and Guidelines.
13. APHA (2023). Standard Methods for the Examination of Water and Wastewater.
14. UNEP Global Environment Reports.
15. World Health Organization (WHO) Reports on Environmental Health.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the definitions, concepts, types, causes, and classification of pollutants including primary and secondary pollutants and their environmental significance.
CO2	Identify major air pollutants—PM2.5, PM10, SO2, NOx, CO, ozone, and greenhouse gases—and analyze their sources, effects, and control measures.
CO3	Analyze the causes, types, and environmental effects of water pollution including eutrophication, waterborne diseases, and surface and groundwater contamination.
CO4	Understand the physical, chemical, and biological characteristics of water pollution and evaluate wastewater treatment methods from primary to tertiary levels.
CO5	Describe soil pollution, noise pollution, and thermal pollution—their sources, impacts on ecosystems and human health, and remediation methods.
CO6	Analyze the management of solid waste, hazardous waste, biomedical waste, e-waste, and radioactive waste using appropriate disposal and treatment strategies.
CO7	Understand pollution monitoring techniques, environmental quality standards, and the application of the Air Quality Index (AQI) in environmental assessment.
CO8	Evaluate pollution prevention, control, and remediation strategies including the principles of reduce, reuse, recycle, recovery, and circular economy.
CO9	Apply knowledge of environmental regulations, pollution control boards, and sustainable practices to minimize environmental impacts.
CO10	Develop critical awareness of emerging issues such as microplastics, single-use plastics, and green technologies for pollution control.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	2	2	2	2	1	1	2
CO2	1	3	3	3	3	2	2	3	2	2
CO3	1	3	3	3	3	2	2	3	2	2
CO4	1	3	2	2	3	2	2	2	2	2
CO5	1	3	3	3	2	2	2	2	1	2
CO6	1	3	2	2	3	2	2	2	2	2
CO7	1	3	3	3	3	2	3	3	2	2
CO8	1	3	3	3	2	2	2	3	2	3
CO9	2	3	2	2	2	3	2	2	1	2
CO10	2	3	3	2	2	3	3	2	2	3

SECOND YEAR **CORE PRACTICAL IV** **SEMESTER IV**

ENVIRONMENTAL POLLUTION LAB

Code: **(Practical)** **Credits: 4**

COURSE OBJECTIVES

- To provide hands-on training in the analysis and monitoring of environmental pollutants.
- To familiarize students with standard methods used for assessing air, water, soil, and noise pollution.
- To develop skills in environmental sample collectin, analysis, interpretation, and reporting.
- To understand environmental quality standards and pollution control measures.

LIST OF EXPERIMENTS

UNIT I. WATER POLLUTION ANALYSIS

1. Estimation of pH by pH meter.
2. Estimation of Electrical Conductivity (EC) by conductivity meter.
3. Estimation of Turbidity by nephelometric method.
4. Estimation of Total Dissolved Solids (TDS) by gravimetric method.
5. Estimation of Dissolved Oxygen (DO) by Winkler's method.
6. Estimation of Total Hardness by EDTA titrimetric method.
7. Estimation of Chloride by argentometric method.

UNIT II. SOIL POLLUTION ANALYSIS

8. Determination of soil pH.
9. Determination of soil electrical conductivity.
10. Estimation of soil organic carbon/organic matter.
11. Determination of available phosphorus in soil.

UNIT III. AIR AND NOISE POLLUTION ANALYSIS

12. Measurement of ambient particulate matter (demonstration).
13. Demonstration of ambient sulfur dioxide (SO_2) and nitrogen oxides (NOx) monitoring.
14. Measurement of ambient noise levels using sound level meter.

UNIT IV. SOLID WASTE AND ENVIRONMENTAL MONITORING

15. Characterization and segregation of municipal solid waste.
16. Identification and classification of biodegradable and non-biodegradable wastes.
17. Field visit to a wastewater treatment plant, solid waste management facility, pollution control laboratory, or recycling unit and submission of a report.

REFERENCES

1. Trivedi, R.K. and Goel, P.K. Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad, 1984.
2. APHA. Standard Methods for the Examination of Water and Wastewater. APHA–AWWA–WEF, Latest Edition.
3. Sawyer, C.N. and McCarty, P.L. Chemistry for Environmental Engineering. McGraw Hill International, 1978.
4. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. Environmental Engineering. McGraw-Hill Education, 2017.
5. Rao, C.S. Environmental Pollution Control Engineering. New Age International Publishers, 2018.
6. Margesin, R. and Schinner, F. Manual of Soil Analysis. Springer, 2005.
7. Central Pollution Control Board (CPCB) Laboratory Manuals and Guidelines.
8. Ministry of Environment, Forest and Climate Change (MoEFCC) Environmental Monitoring Guidelines.
9. APHA Water Analysis Manuals and WHO Water Quality Guidelines.

10. UNEP and WHO Environmental Monitoring Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Collect, handle, and preserve environmental samples—water, soil, air—following standard scientific procedures and safety protocols.
CO2	Estimate key physico-chemical parameters of water including pH, electrical conductivity, turbidity, TDS, dissolved oxygen, total hardness, and chloride.
CO3	Analyze soil quality parameters including pH, electrical conductivity, organic carbon, organic matter, and available phosphorus using standard methods.
CO4	Measure and interpret ambient air quality and noise pollution levels using appropriate monitoring instruments and standard methods.
CO5	Identify and classify municipal solid waste into biodegradable and non-biodegradable categories and explain appropriate disposal practices.
CO6	Compare analytical results with national and international environmental quality standards set by CPCB, WHO, and other regulatory bodies.
CO7	Develop skills in environmental data recording, interpretation, and scientific report writing for pollution assessment studies.
CO8	Recommend suitable pollution prevention and control measures based on laboratory findings and environmental quality data.
CO9	Conduct field visits to pollution control facilities—wastewater treatment plants, solid waste management sites—and prepare detailed visit reports.
CO10	Apply laboratory findings to understand real-world environmental pollution scenarios and develop critical problem-solving skills in pollution management.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	1	**3**	2	2	2	2	1
CO2	1	**3**	2	**3**	**3**	2	2	**3**	2	2
CO3	1	**3**	2	**3**	**3**	2	2	**3**	2	2
CO4	1	2	2	2	**3**	2	2	2	2	1
CO5	1	2	2	2	2	2	2	2	1	1
CO6	1	**3**	**3**	**3**	**3**	2	**3**	**3**	2	2
CO7	2	2	**3**	**3**	2	**3**	2	2	2	2
CO8	2	**3**	**3**	**3**	2	**3**	**3**	**3**	2	**3**
CO9	**3**	2	2	2	2	**3**	**3**	2	2	2
CO10	2	**3**	**3**	**3**	2	**3**	**3**	**3**	2	**3**

THIRD YEAR **CORE COURSE 5** **SEMESTER V**

ENVIRONMENTAL MICROBIOLOGY

Code: (Theory) **Credits: 4**

COURSE OBJECTIVES

- To understand the diversity, structure, and functions of microorganisms in the environment.
- To study the role of microorganisms in ecosystem processes and nutrient cycling.
- To understand the significance of microorganisms in environmental pollution and public health.
- To introduce the applications of microorganisms in environmental management and sustainable development.
- To develop knowledge on microbial technologies used in waste treatment and bioremediation.

UNIT – I: INTRODUCTION TO ENVIRONMENTAL MICROBIOLOGY

History, scope, and importance of environmental microbiology; Classification of microorganisms; General characteristics of bacteria, fungi, algae, protozoa, and viruses; Structure of prokaryotic and eukaryotic cells; Growth and reproduction of microorganisms; Beneficial and harmful microorganisms.

UNIT – II: MICROBIAL ECOLOGY

Distribution of microorganisms in soil, water, and air; Factors influencing microbial growth and distribution; Microbial interactions – mutualism, commensalism, parasitism, competition, and predation; Rhizosphere microorganisms and plant-microbe interactions; Role of microorganisms in ecosystem functioning.

UNIT – III: MICROORGANISMS IN BIOGEOCHEMICAL CYCLES

Role of microorganisms in nutrient cycling; Carbon cycle and decomposition; Nitrogen cycle – nitrogen fixation, ammonification, nitrification, and denitrification; Phosphorus and sulfur cycles; Microbial contribution to soil fertility and ecosystem productivity.

UNIT – IV: ENVIRONMENTAL HEALTH AND MICROBIAL POLLUTION

Airborne microorganisms and bioaerosols; Waterborne and foodborne diseases; Microbial contamination of air, water, and soil; Indicator microorganisms of environmental pollution; Assessment of microbiological quality of water; Most Probable Number (MPN) technique and Biological Oxygen Demand (BOD); Public health significance of environmental microorganisms.

UNIT – V: APPLIED ENVIRONMENTAL MICROBIOLOGY

Wastewater treatment – aerobic and anaerobic processes; Activated sludge process and biogas production; Bioremediation of contaminated environments; Biofertilizers and biopesticides; Composting and vermicomposting; Microbial applications in solid waste management and sustainable agriculture.

UNIT – VI: CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Microplastics and Microbial Degradation; Environmental DNA (eDNA) and Biodiversity Monitoring; Emerging Waterborne Diseases; Microbial Solutions for Climate Change Mitigation; Biofertilizers for Sustainable Agriculture; Circular Bioeconomy and Waste-to-Resource Technologies.

REFERENCES

1. Atlas, R.M. and Bartha, R. (2011). Microbial Ecology: Fundamentals and Applications. Benjamin Cummings Publishing.
2. Pepper, I.L., Gerba, C.P. and Gentry, T.J. (2015). Environmental Microbiology. Academic Press.
3. Maier, R.M., Pepper, I.L. and Gerba, C.P. (2009). Environmental Microbiology. Elsevier Academic Press.
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7. Jemba, P.K. (2004). Environmental Microbiology. Science Publishers.
8. Srivastava, M.L. (2003). Basic Environmental Microbiology. Manohar Publishers.
9. Sharma, P.D. (2020). Ecology and Environment. Rastogi Publications.
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12. Tortora, G.J., Funke, B.R. and Case, C.L. (2020). Microbiology: An Introduction. Pearson Education.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Describe the classification, structural characteristics, and functions of major environmental microorganisms including bacteria, fungi, algae, protozoa, and viruses.
CO2	Explain the distribution of microorganisms in soil, water, and air, and identify the factors influencing their growth, distribution, and ecological roles.
CO3	Analyze microbial interactions—mutualism, commensalism, parasitism, competition, and predation—and explain plant-microbe interactions in the rhizosphere.
CO4	Describe the role of microorganisms in major biogeochemical cycles—carbon, nitrogen, phosphorus, and sulfur cycles—and their contribution to ecosystem productivity.
CO5	Identify major microbial pollutants, waterborne and foodborne pathogens, and bioaerosols, and assess their significance for environmental and public health.
CO6	Apply microbiological techniques including MPN method, BOD analysis, and water quality assessment to evaluate the microbiological quality of environmental samples.
CO7	Understand the principles of aerobic and anaerobic wastewater treatment, activated sludge processes, and biogas production for sustainable waste management.
CO8	Evaluate the applications of bioremediation, biofertilizers, biopesticides, composting, and vermicomposting in environmental management and sustainable agriculture.
CO9	Analyze emerging trends in environmental microbiology including microbial degradation of microplastics, environmental DNA (eDNA), and circular bioeconomy approaches.
CO10	Develop awareness of microbial technologies for climate change mitigation and sustainable resource management in environmental science.

CO-PO Mapping

Mapping Level: 3 = High Correlation | 2 = Medium Correlation | 1 = Low Correlation

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	2	2	**3**	2	2	1	1	2
CO3	1	**3**	**3**	**3**	2	2	2	2	2	2
CO4	1	**3**	2	**3**	**3**	2	2	2	2	2
CO5	1	**3**	**3**	**3**	2	2	2	2	2	2
CO6	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	**3**	2	2	**3**	2	2	2	1	2
CO8	1	**3**	**3**	2	2	2	2	2	2	**3**
CO9	2	**3**	**3**	2	2	**3**	**3**	2	2	**3**
CO10	2	**3**	2	2	2	**3**	**3**	2	2	**3**

THIRD YEAR **CORE COURSE VI** **SEMESTER V**

BIOSTATISTICS AND COMPUTATION

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To introduce the fundamental concepts and applications of biostatistics in environmental sciences.
- To develop skills in collection, organization, analysis, and interpretation of environmental data.
- To understand probability distributions and statistical methods used in ecological and environmental studies.
- To familiarize students with computer applications and statistical software for environmental data analysis.
- To provide a foundation for research methodology and scientific reporting.

UNIT – I: INTRODUCTION TO BIOSTATISTICS

Biostatistics: Definition, scope, and importance; Types of data; Collection and classification of data; Sampling methods; Frequency distribution; Tabulation and graphical representation of data – bar diagrams, histograms, pie charts, frequency polygons, and ogives.

UNIT – II: DESCRIPTIVE STATISTICS

Measures of central tendency – mean, median, and mode; Measures of dispersion – range, variance, standard deviation, and coefficient of variation; Skewness and kurtosis; Data interpretation and presentation in environmental studies.

UNIT – III: PROBABILITY AND STATISTICAL INFERENCE

Basic concepts of probability; Probability distributions – binomial, Poisson, and normal distributions; Sampling distribution; Standard error; Confidence intervals; Introduction to hypothesis testing; Errors in statistical testing.

UNIT – IV: STATISTICAL TESTS AND CORRELATION

Tests of significance – t-test, Chi-square test, and Analysis of Variance (ANOVA); Correlation and regression analysis; Interpretation of statistical outputs; Applications of statistical methods in ecology and environmental science.

UNIT – V: COMPUTATION AND DATA ANALYSIS

Introduction to computers and data management; Spreadsheet applications using MS Excel/Open-source software; Data entry, sorting, filtering, and graphical presentation; Statistical analysis using spreadsheet tools; Introduction to statistical software packages (R, PSPP, SPSS, or equivalent open-source software); Applications in environmental monitoring and biodiversity assessment.

UNIT – VI: CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Big Data in Environmental Science; Artificial Intelligence and Environmental Analytics; Data Visualization Techniques; Citizen Science and Environmental Data; Open-Source Statistical Software; Environmental Modelling and Decision Support Systems.

REFERENCES

1. Zar, J.H. (2010). Biostatistical Analysis. Pearson Education.
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3. Sokal, R.R. and Rohlf, F.J. (2012). Biometry. W.H. Freeman and Company.
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8. Triola, M.F. (2022). Elementary Statistics. Pearson Education.
9. Elmasri, R. and Navathe, S.B. (2016). Fundamentals of Database Systems. Pearson.
10. Microsoft Excel Documentation and Tutorials.
11. R Core Team. Introduction to R for Statistical Computing.
12. Kothari, C.R. (2004). Research Methodology: Methods and Techniques. New Age International Publishers.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the scope and importance of biostatistics in environmental science and differentiate types of data, sampling methods, and data classification.
CO2	Collect, organize, and present environmental data using appropriate graphical representations—bar diagrams, histograms, pie charts, and frequency polygons.
CO3	Calculate and interpret measures of central tendency—mean, median, mode—and measures of dispersion—range, variance, standard deviation, CV.
CO4	Apply concepts of probability and statistical distributions—binomial, Poisson, and normal—to environmental data sets and ecological studies.
CO5	Understand the principles of sampling distributions, standard error, confidence intervals, and hypothesis testing including Type I and Type II errors.
CO6	Perform and interpret tests of significance including t-test, Chi-square test, and ANOVA for environmental and ecological datasets.
CO7	Apply correlation and regression analysis to establish relationships between environmental variables and interpret statistical outputs.
CO8	Use spreadsheet tools such as MS Excel or open-source equivalents for data entry, sorting, graphical presentation, and basic statistical computations.
CO9	Apply statistical software packages—R, PSPP, or equivalent—for advanced environmental data analysis, biodiversity assessment, and modeling.
CO10	Analyze and communicate scientific data effectively in environmental research reports, supporting evidence-based decision-making.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	2	**3**	2	2	2	2	2	2	1	2
CO3	1	**3**	**3**	**3**	**3**	2	2	**3**	1	2
CO4	1	**3**	2	**3**	**3**	2	2	2	2	2
CO5	1	**3**	2	**3**	**3**	2	2	2	2	2
CO6	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO8	1	2	2	2	**3**	**3**	2	**3**	2	2
CO9	1	2	**3**	**3**	**3**	**3**	2	**3**	**3**	2
CO10	**3**	**3**	**3**	**3**	2	**3**	2	**3**	**3**	**3**

THIRD YEAR **CORE COURSE 7** **SEMESTER V**

ENVIRONMENTAL TOOLS AND TECHNIQUES

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To introduce the fundamental tools and techniques used in environmental studies and research.
- To provide knowledge on environmental monitoring, assessment, and data collection methods.
- To familiarize students with modern geospatial technologies such as Remote Sensing and Geographic Information Systems (GIS).
- To develop skills in environmental data analysis, interpretation, and decision-making.
- To understand the applications of environmental tools in resource management, pollution monitoring, and biodiversity conservation.

UNIT – I: ENVIRONMENTAL MONITORING AND SAMPLING TECHNIQUES

Environmental monitoring: Concept, objectives, and importance; Environmental quality standards; Sampling techniques for air, water, soil, and biological samples; Sample collection, preservation, transportation, and storage; Environmental data collection and field survey methods; Introduction to environmental instrumentation.

UNIT – II: ENVIRONMENTAL ANALYTICAL TECHNIQUES

Physical, chemical, and biological analysis of environmental samples; Measurement of pH, conductivity, dissolved oxygen, turbidity, and particulate matter; Spectrophotometry and colorimetry; Chromatographic techniques – principles and applications; Bioindicators and biomonitoring; Environmental data interpretation.

UNIT – III: REMOTE SENSING

Principles of Remote Sensing; Electromagnetic spectrum and energy interactions; Platforms and sensors; Types of Remote Sensing – passive and active remote sensing; Satellite systems and applications; Image interpretation elements; Applications of Remote Sensing in land use and land cover mapping, agriculture, forestry, water resources, biodiversity assessment, disaster management, and climate studies.

UNIT – IV: GEOGRAPHIC INFORMATION SYSTEM (GIS)

Introduction to GIS; Components of GIS; Spatial and attribute data; Data input, storage, retrieval, and analysis; Vector and raster data models; Map projections and coordinate systems; GIS database management; Applications of GIS in environmental management and planning.

UNIT – V: ENVIRONMENTAL IMPACT ASSESSMENT AND DECISION SUPPORT TOOLS

Environmental Impact Assessment (EIA): Concepts, objectives, and procedures; Screening, scoping, impact prediction, and mitigation measures; Environmental auditing; Risk assessment and environmental management plans; Decision support systems; Applications of GIS and Remote Sensing in EIA and environmental planning.

UNIT – VI: CURRENT CONTOURS ***(For Continuous Internal Assessment Only)***

Artificial Intelligence in Environmental Monitoring; Drone-Based Environmental Surveys; Geographic Information Systems for Smart Cities; Internet of Things (IoT) in Environmental Monitoring; Environmental Big Data Analytics; Open-Source GIS Platforms (QGIS); Climate Change Monitoring Using Satellite Data.

REFERENCES

1. Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2015). Remote Sensing and Image Interpretation. Wiley.
2. Campbell, J.B. and Wynne, R.H. (2011). Introduction to Remote Sensing. Guilford Press.
3. Burrough, P.A. and McDonnell, R.A. (2015). Principles of Geographical Information Systems. Oxford University Press.
4. Chang, K.T. (2021). Introduction to Geographic Information Systems. McGraw-Hill Education.
5. Lo, C.P. and Yeung, A.K.W. (2016). Concepts and Techniques of Geographic Information Systems. Pearson Education.
6. Jensen, J.R. (2016). Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson.
7. Rao, C.S. (2018). Environmental Pollution Control Engineering. New Age International Publishers.
8. Trivedi, R.K. and Goel, P.K. Practical Methods in Ecology and Environmental Science. Environmental Publications.
9. Manahan, S.E. (2017). Environmental Chemistry. CRC Press.
10. Weng, Q. (2010). Remote Sensing and GIS Integration: Theories, Methods and Applications. McGraw-Hill.
11. United Nations Environment Programme (UNEP) Environmental Assessment Manuals.
12. QGIS Documentation and Open-Source GIS Training Materials.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the objectives, principles, and importance of environmental monitoring and explain the sampling techniques used for air, water, soil, and biological samples.
CO2	Apply physical, chemical, and biological analytical techniques—spectrophotometry, chromatography, colorimetry—for environmental quality assessment.
CO3	Explain the principles of Remote Sensing, the electromagnetic spectrum, energy interactions, and the classification of platforms and sensors.
CO4	Apply remote sensing data and satellite imagery for land use and land cover mapping, agriculture, forestry, water resource, and biodiversity assessment.
CO5	Describe the components of GIS, spatial and attribute data types, data input methods, and vector and raster data models for environmental mapping.
CO6	Apply GIS tools for environmental management, planning, spatial analysis, and data-driven decision-making in resource management.
CO7	Understand the concepts, objectives, and procedural steps of Environmental Impact Assessment including screening, scoping, prediction, and mitigation.
CO8	Evaluate environmental auditing, risk assessment, and environmental management plans and their role in sustainable environmental governance.
CO9	Apply integrated geospatial tools—GIS and Remote Sensing—for Environmental Impact Assessment and sustainable environmental planning.
CO10	Analyze emerging technologies including AI, drones, IoT, and open-source GIS platforms for next-generation environmental monitoring and decision support.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	**3**	2	2	2	1	2
CO2	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO3	1	**3**	2	2	**3**	2	2	1	1	2
CO4	1	**3**	**3**	2	**3**	2	2	2	2	2
CO5	1	**3**	2	2	**3**	2	2	1	1	2
CO6	1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	2	2
CO7	1	**3**	**3**	**3**	2	2	2	2	2	2
CO8	1	**3**	**3**	**3**	2	**3**	**3**	2	2	2
CO9	1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	2
CO10	2	**3**	**3**	2	**3**	**3**	**3**	2	2	**3**

THIRD YEAR **CORE COURSE 8** **SEMESTER V**

ENVIRONMENTAL LAW AND TECHNIQUES

Code: **(Theory)** **Credits: 5**

COURSE OBJECTIVES

- To provide an understanding of environmental laws, policies, and governance mechanisms.
- To familiarize students with national and international environmental regulations.
- To introduce environmental management and assessment techniques used in environmental protection.
- To develop awareness of environmental rights, responsibilities, and legal compliance.
- To understand the application of modern environmental monitoring and management tools.

UNIT – I: INTRODUCTION TO ENVIRONMENTAL LAW

Concept and scope of Environmental Law; Evolution of environmental legislation; Environmental ethics and environmental justice; Constitutional provisions related to environmental protection in India; Fundamental Rights, Fundamental Duties, and Directive Principles of State Policy; Environmental governance and sustainable development.

UNIT – II: NATIONAL ENVIRONMENTAL LEGISLATIONS

Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Environment (Protection) Act, 1986; Wildlife (Protection) Act, 1972; Forest (Conservation) Act, 1980; Biological Diversity Act, 2002; National Green Tribunal (NGT) Act, 2010; Roles and functions of CPCB and SPCBs.

UNIT – III: INTERNATIONAL ENVIRONMENTAL AGREEMENTS

International environmental governance; Stockholm Conference (1972); Rio Earth Summit (1992); Agenda 21; Convention on Biological Diversity (CBD); Ramsar Convention; Convention on International Trade in Endangered Species (CITES); Montreal Protocol; Kyoto Protocol; Paris Agreement on Climate Change; Sustainable Development Goals (SDGs).

UNIT – IV: ENVIRONMENTAL IMPACT ASSESSMENT AND AUDIT

Environmental Impact Assessment (EIA): Concept, objectives, process, and significance; Environmental Clearance Procedures; Environmental Management Plan (EMP); Environmental Auditing; Environmental Risk Assessment; Public participation in environmental decision-making; Case studies of EIA in India.

UNIT – V: ENVIRONMENTAL MONITORING AND MANAGEMENT TECHNIQUES

Environmental Monitoring: Air, water, soil, and noise quality monitoring; Environmental Quality Standards; Geographic Information Systems (GIS) and Remote Sensing applications in environmental management; Environmental Information Systems; Waste management techniques; Cleaner production and pollution prevention technologies.

UNIT – VI: CURRENT CONTOURS ***(For Continuous Internal Assessment Only)***

National Green Tribunal Judgements; Environmental Litigation in India; Climate Change Laws and Policies; ESG (Environmental, Social and Governance) Frameworks; Green Technologies; Carbon Credits and Carbon Trading; Environmental Compliance and Corporate Responsibility.

REFERENCES

1. Divan, S. and Rosencranz, A. (2022). Environmental Law and Policy in India. Oxford University Press.
2. Shastri, S.C. (2021). Environmental Law. Eastern Book Company.
3. P. Leelakrishnan (2019). Environmental Law in India. LexisNexis Publications.
4. Ball, S. and Bell, S. (2018). Environmental Law. Oxford University Press.
5. Benny Joseph (2017). Environmental Studies. McGraw-Hill Education.
6. Uberoi, N.K. (2018). Environmental Management. Excel Books.
7. Bharucha, E. (2019). Textbook of Environmental Studies. Universities Press.

8. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India Publications.
9. Central Pollution Control Board (CPCB) Manuals and Guidelines.
10. National Green Tribunal (NGT) Reports and Case Documents.
11. UNEP Environmental Governance Reports.
12. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environment and Resource Conservation. Anamaya Publishers.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the concept, scope, and evolution of environmental law, and describe constitutional provisions and environmental governance frameworks in India.
CO2	Describe the major national environmental legislations—Water Act 1974, Air Act 1981, EPA 1986, Wildlife Act, Forest Act, Biological Diversity Act—and their significance.
CO3	Explain the roles and functions of regulatory bodies including CPCB, SPCBs, and the National Green Tribunal in environmental protection.
CO4	Analyze major international environmental agreements including Stockholm Conference, Rio Summit, CBD, Ramsar, CITES, Montreal Protocol, Kyoto Protocol, and Paris Agreement.
CO5	Understand the concepts, objectives, and procedural steps of Environmental Impact Assessment and its role in environmental clearance processes in India.
CO6	Evaluate Environmental Auditing, Environmental Risk Assessment, Environmental Management Plans, and the importance of public participation in decision-making.
CO7	Apply environmental monitoring techniques—air, water, soil, and noise—and understand environmental quality standards for compliance and management.
CO8	Use GIS and Remote Sensing applications in environmental law enforcement, monitoring, and sustainable environmental planning.
CO9	Evaluate environmental legal issues, case studies from the NGT, ESG frameworks, carbon credits, and corporate environmental compliance.
CO10	Develop critical perspectives on environmental justice, climate change laws, rights-based approaches to environment, and sustainable environmental governance.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	2	**3**	2	2	2	2	2	1	1	2
CO3	2	**3**	2	2	2	2	2	1	1	2
CO4	2	**3**	**3**	**3**	2	**3**	2	2	2	2
CO5	1	**3**	**3**	**3**	2	2	2	2	2	2
CO6	1	**3**	**3**	**3**	2	**3**	**3**	2	2	2
CO7	1	**3**	**3**	**3**	**3**	2	**3**	**3**	2	2
CO8	1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	2	2
CO9	2	**3**	**3**	2	2	**3**	**3**	2	2	**3**
CO10	**3**	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**

Third Year **CORE PRACTICAL 5** **Semester V**

ENVIRONMENTAL MICROBILOGY

Code **(Practical)** **Credit: 4**

1. Introduction to General Microbiology: Laboratory Rules, Microscopy,
2. Sterilization, Preparation of Culture Media, Isolation of Bacteria from Soil,
3. Isolation of fungi from Soil, Ubiquitous nature of Microorganisms.
4. Types of staining techniques: Simple staining, Gram staining, Capsular staining and Endospore staining.
5. Demonstration of motility for bacteria by hanging drop technique
6. List of Biochemical Test: Indole production, Methyl Red, Voges Proskaeur,
7. Citrate Utilization, Triple sugar-Iron agar, Catalase and Oxidase Test
8. Antibiotic sensitivity test: Disc diffusion method
9. Most Probable Number (MPN): Presumptive, Confirmatory and complete test
10. Identification of Fungi: Lacto phenol cotton blue test

REFERENCES:

Willey. Prescott's Microbiology. New York: McGraw-Hill, 2011.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Demonstrate proper laboratory safety practices, microscopy skills, and understanding of microbial diversity encountered in environmental samples.
CO2	Perform sterilization procedures, prepare culture media, and isolate bacteria and fungi from soil and environmental sources.
CO3	Identify the ubiquitous nature of microorganisms in different environmental matrices through controlled laboratory experiments.
CO4	Apply staining techniques—simple, Gram, capsular, and endospore staining—to characterize and differentiate bacterial species.
CO5	Demonstrate bacterial motility using hanging drop technique and relate motility to ecological adaptations of microorganisms.
CO6	Perform a series of biochemical tests including indole, methyl red, Voges–Proskauer, citrate utilization, TSI, catalase, and oxidase tests for microbial identification.
CO7	Conduct antibiotic sensitivity testing using the disc diffusion method and interpret results in relation to environmental health implications.
CO8	Execute the MPN technique including presumptive, confirmatory, and complete tests for microbiological water quality assessment.
CO9	Identify fungi using lactophenol cotton blue staining and relate fungal diversity to ecological decomposition and soil health.
CO10	Develop laboratory competency to safely and effectively perform routine microbial culture, isolation, identification, and characterization procedures.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	1	2	2	2	1	1	1
CO2	1	**3**	2	2	**3**	2	2	2	2	2
CO3	1	2	2	2	**3**	2	2	2	1	1
CO4	1	**3**	2	2	**3**	2	2	2	1	2
CO5	1	2	2	2	**3**	2	2	2	1	1
CO6	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	2	2	2	**3**	2	2	2	2	2
CO8	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO9	1	2	2	2	**3**	2	2	2	1	2
CO10	1	2	2	2	2	**3**	2	2	2	2

THIRD YEAR **CORE COURSE 9** **SEMESTER VI**

ENVIRONMENTAL TOXICOLOGY

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To introduce the fundamental principles and concepts of environmental toxicology.
- To understand the sources, transport, fate, and effects of environmental toxicants.
- To study the impact of toxic substances on ecosystems, wildlife, and human health.
- To familiarize students with toxicity testing and environmental risk assessment.
- To develop awareness of toxic pollutants and their management for environmental protection.

UNIT – I: FUNDAMENTALS OF TOXICOLOGY

Introduction to Toxicology: Definition, scope, and importance; Principles of toxicology; Toxicants and toxins; Sources of environmental toxicants; Exposure pathways and routes of entry (inhalation, ingestion, dermal absorption); Dose-response relationship; Concepts of LD_{50}, LC_{50}, and ED_{50}; Acute and chronic toxicity; Factors influencing toxicity.

UNIT – II: ENVIRONMENTAL FATE OF TOXICANTS

Sources and distribution of toxic substances in air, water, soil, and food; Environmental transport and transformation of pollutants; Bioaccumulation, biomagnification, and biotransformation; Persistence of toxic chemicals in ecosystems; Toxic pollutants in food chains and food webs.

UNIT – III: MAJOR ENVIRONMENTAL TOXICANTS

Heavy metals (lead, mercury, cadmium, arsenic); Pesticides and agrochemicals; Industrial pollutants; Persistent Organic Pollutants (POPs); Plastics and microplastics; Emerging contaminants including pharmaceuticals and personal care products; Sources, environmental behavior, and impacts.

UNIT – IV: ECOTOXICOLOGY AND TOXICITY ASSESSMENT

Concept of ecotoxicology; Effects of toxicants on plants, animals, and microorganisms; Toxicity testing and bioassays; Biomarkers and bioindicators; Principles of environmental risk assessment; Threshold Limit Value (TLV) and safety standards; Applications and limitations of toxicity assessment methods.

UNIT – V: HUMAN HEALTH AND TOXIC EFFECTS

Health effects of environmental pollutants; Organ toxicity – hepatotoxicity, nephrotoxicity, neurotoxicity, pulmonary toxicity, and reproductive toxicity; Carcinogenicity, mutagenicity, and teratogenicity; Occupational exposure to toxic substances; Prevention and management of toxic exposures.

UNIT – VI: CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Microplastics and Human Health; Endocrine Disrupting Chemicals (EDCs); PFAS ("Forever Chemicals"); Electronic Waste Toxicity; Environmental Health Risk Assessment; Industrial Toxic Disasters; Climate Change and Toxic Pollutant Dynamics; Recent Case Studies from India and Abroad.

REFERENCES

1. Klaassen, C.D. (2021). Casarett and Doull's Toxicology: The Basic Science of Poisons. McGraw-Hill Education.
2. Roberts, S.M., James, R.C. and Williams, P.L. (2015). Principles of Toxicology: Environmental and Industrial Applications. John Wiley & Sons.
3. Shaw, I.C. and Chadwick, J. (1998). Principles of Environmental Toxicology. CRC Press.
4. Sparling, D.W. (2017). Basics of Ecotoxicology. CRC Press.
5. Walker, C.H., Sibly, R.M., Hopkin, S.P. and Peakall, D.B. (2012). Principles of Ecotoxicology. CRC Press.
6. Kaiden Higgins (2017). Environmental Toxicology. Larsen and Keller Education.
7. Manahan, S.E. (2017). Environmental Chemistry. CRC Press.
8. De, A.K. (2017). Environmental Chemistry. New Age International Publishers.
9. Cunningham, W.P. and Cunningham, M.A. (2020). Environmental Science: A Global Concern. McGraw-Hill Education.
10. Sharma, P.D. (2020). Ecology and Environment. Rastogi Publications.
11. World Health Organization (WHO) Reports on Environmental Health.
12. United Nations Environment Programme (UNEP) Publications on Chemicals and Waste.
13. Central Pollution Control Board (CPCB) Reports and Guidelines.
14. Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles.
15. Environmental Protection Agency (EPA) Toxicity Assessment Manuals.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the fundamental principles of toxicology including dose-response relationships, LD50, LC50, ED50, and the distinction between acute and chronic toxicity.
CO2	Describe the sources, exposure pathways—inhalation, ingestion, dermal absorption—and routes of entry of environmental toxicants into organisms.
CO3	Analyze the environmental transport, transformation, bioaccumulation, biomagnification, and persistence of toxic chemicals in ecosystems and food chains.
CO4	Identify and describe major classes of environmental toxicants—heavy metals, pesticides, POPs, microplastics, and emerging contaminants—and their sources and behaviors.
CO5	Explain the concepts of ecotoxicology and evaluate the effects of toxicants on plants, animals, and microorganisms in terrestrial and aquatic ecosystems.
CO6	Apply toxicity testing methods, bioassays, biomarkers, and bioindicators for environmental toxicity assessment and interpretation.
CO7	Understand the principles of environmental risk assessment, Threshold Limit Values (TLV), and safety standards for toxic substances.
CO8	Analyze the human health effects of environmental pollutants including organ toxicity—hepatotoxicity, nephrotoxicity, neurotoxicity—carcinogenicity, mutagenicity, and teratogenicity.
CO9	Evaluate strategies for prevention and management of toxic exposures in occupational and environmental settings.
CO10	Interpret contemporary toxicological issues such as microplastics, endocrine disrupting chemicals, PFAS, e-waste toxicity, and industrial toxic disasters.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	**3**	2	2	2	1	2
CO2	1	**3**	2	2	**3**	2	2	2	1	2
CO3	1	**3**	**3**	**3**	2	2	2	2	2	2
CO4	1	**3**	2	2	2	2	2	1	1	2
CO5	1	**3**	**3**	**3**	2	2	2	2	2	2
CO6	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	**3**	2	**3**	**3**	2	2	2	2	2
CO8	2	**3**	**3**	**3**	2	2	2	**3**	2	2
CO9	2	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**
CO10	2	**3**	**3**	2	2	**3**	**3**	2	2	**3**

THIRD YEAR **CORE COURSE 10** **SEMESTER VI**

CLIMATE CHANGE AND SUSTAINABILITY

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To provide a comprehensive understanding of climate change, its causes, impacts, and mitigation strategies.
- To understand the scientific basis of climate change and its influence on natural and human systems.
- To examine the concepts and principles of sustainability and sustainable development.
- To familiarize students with climate change adaptation, resilience, and policy frameworks.
- To develop awareness of sustainable practices for environmental conservation and resource management.

UNIT – I: INTRODUCTION TO CLIMATE CHANGE

Weather and Climate: Concepts and differences; Climate system and its components; Greenhouse effect and greenhouse gases; Causes of climate change – natural and anthropogenic factors; Evidence of climate change; Global warming and climate variability; Overview of climate science and climate modeling.

UNIT – II: IMPACTS OF CLIMATE CHANGE

Climate change impacts on atmosphere, hydrosphere, lithosphere, and biosphere; Effects on ecosystems and biodiversity; Impacts on agriculture, water resources, forests, fisheries, and human health; Extreme weather events – floods, droughts, heat waves, cyclones, and sea-level rise; Vulnerability and risk assessment.

UNIT – III: CLIMATE CHANGE MITIGATION

Mitigation: Concepts and approaches; Reduction of greenhouse gas emissions; Renewable energy technologies; Energy efficiency and conservation; Carbon sequestration and carbon capture; Sustainable transportation; Green buildings and low-carbon development; Nature-based solutions for climate mitigation.

UNIT – IV: CLIMATE CHANGE ADAPTATION AND RESILIENCE

Adaptation to climate change: Concepts and strategies; Climate-resilient agriculture; Water resource adaptation measures; Disaster risk reduction and climate resilience; Community-based adaptation; Ecosystem-based adaptation; Climate-smart development practices.

UNIT – V: SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

Concept and principles of sustainability; Sustainable Development Goals (SDGs); Environmental, social, and economic dimensions of sustainability; Circular economy; Sustainable consumption and production; Ecological footprint and carbon footprint; Corporate sustainability and Environmental, Social and Governance (ESG) principles; Sustainable lifestyles and green technologies.

UNIT – VI: CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Global Climate Agreements and COP Summits; Paris Agreement and Net-Zero Emissions; Climate Justice and Equity; Climate Finance and Carbon Markets; Loss and Damage Fund; Youth and Climate Action; Sustainable Cities and Smart Communities; Climate Change in India – Challenges and Opportunities.

REFERENCES

1. IPCC (Latest Assessment Reports). Climate Change: Synthesis Reports.
2. Dessler, A.E. (2021). Introduction to Modern Climate Change. Cambridge University Press.
3. Maslin, M. (2021). Climate Change: A Very Short Introduction. Oxford University Press.
4. Houghton, J. (2015). Global Warming: The Complete Briefing. Cambridge University Press.
5. Henderson-Sellers, A. and Robinson, P.J. (2013). Contemporary Climatology. Routledge.
6. Miller, G.T. and Spoolman, S. (2018). Living in the Environment. Cengage Learning.
7. Cunningham, W.P. and Cunningham, M.A. (2020). Environmental Science: A Global Concern. McGraw-Hill Education.
8. Sachs, J.D. (2015). The Age of Sustainable Development. Columbia University Press.
9. United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development.
10. UNEP Global Environment Outlook Reports.
11. MoEFCC, Government of India. National Action Plan on Climate Change (NAPCC).
12. TERI Publications on Climate Change and Sustainability.
13. Bharucha, E. (2019). Textbook of Environmental Studies. Universities Press.
14. Sharma, P.D. (2020). Ecology and Environment. Rastogi Publications.
15. United Nations Framework Convention on Climate Change (UNFCCC) Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the scientific basis of climate change, greenhouse effect, greenhouse gases, natural and anthropogenic causes, and global climate variability.
CO2	Describe evidence of climate change and explain the functioning of the climate system and the role of climate modeling in understanding future projections.
CO3	Analyze the impacts of climate change on atmosphere, hydrosphere, lithosphere, biosphere, biodiversity, agriculture, water resources, and human health.
CO4	Evaluate the risks posed by extreme weather events—floods, droughts, heat waves, cyclones, sea-level rise—and assess community vulnerability.
CO5	Understand climate change mitigation strategies including renewable energy technologies, energy efficiency, carbon sequestration, and nature-based solutions.
CO6	Apply adaptation concepts—climate-resilient agriculture, water adaptation, ecosystem-based adaptation, climate-smart development—to sustainable development planning.
CO7	Explain the principles and dimensions of sustainability—environmental, social, and economic—and evaluate the Sustainable Development Goals (SDGs).
CO8	Assess the concepts of circular economy, ecological footprint, carbon footprint, ESG principles, and sustainable consumption and production.
CO9	Evaluate international climate agreements—Paris Agreement, COP summits, carbon markets, climate finance—and understand the role of climate justice and equity.
CO10	Develop informed perspectives on climate action, low-carbon development, sustainable cities, and solutions addressing climate challenges in the Indian context.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	**3**	2	2	1	1	2
CO2	1	**3**	2	2	**3**	2	2	1	2	2
CO3	1	**3**	**3**	**3**	2	2	2	2	2	2
CO4	1	**3**	**3**	**3**	2	2	2	**3**	2	2
CO5	1	**3**	**3**	2	2	2	2	2	2	**3**
CO6	1	**3**	**3**	2	2	2	2	2	2	**3**
CO7	1	**3**	2	2	2	**3**	2	1	1	**3**
CO8	1	**3**	2	2	2	**3**	2	2	1	**3**
CO9	2	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**
CO10	**3**	**3**	**3**	2	2	**3**	**3**	2	2	**3**

THIRD YEAR **CORE COURSE 11** **SEMESTER VI**

ENVIRONMENTAL SAFETY AND HEALTH MANAGEMENT

Code: **(Theory)** **Credits: 4**

COURSE OBJECTIVES

- To introduce the principles and practices of environmental safety and occupational health management.
- To understand workplace hazards, risk assessment, and accident prevention strategies.
- To familiarize students with environmental health issues and safety regulations.
- To develop knowledge on emergency preparedness, disaster management, and occupational safety.
- To promote safe working environments and sustainable health management practices.

UNIT – I: INTRODUCTION TO ENVIRONMENTAL SAFETY AND HEALTH

Concept and scope of Environmental Safety and Health Management; Environment, Health, and Safety (EHS) principles; Occupational health and safety; Importance of workplace safety; Types of hazards – physical, chemical, biological, ergonomic, and psychosocial hazards; Environmental health and public health concepts.

UNIT – II: OCCUPATIONAL HAZARDS AND RISK ASSESSMENT

Occupational hazards in industries, laboratories, and field environments; Hazard identification and classification; Exposure pathways and health effects; Risk assessment process – hazard identification, exposure assessment, risk characterization, and risk management; Safety signs and symbols; Personal Protective Equipment (PPE) and its applications.

UNIT – III: INDUSTRIAL SAFETY AND ACCIDENT PREVENTION

Industrial accidents and their causes; Accident investigation and reporting; Safety audits and inspections; Fire hazards, fire prevention, and fire-fighting equipment; Electrical safety; Chemical safety and hazardous material handling; Safe laboratory practices; Occupational safety measures in environmental monitoring and field studies.

UNIT – IV: ENVIRONMENTAL HEALTH MANAGEMENT

Environmental determinants of health; Water, air, and food-related health issues; Vector-borne and waterborne diseases; Waste management and sanitation; Environmental hygiene; Health surveillance and occupational health programmes; Environmental health indicators and monitoring.

UNIT – V: EMERGENCY PREPAREDNESS AND DISASTER MANAGEMENT

Emergency planning and preparedness; Disaster management cycle – prevention, mitigation, preparedness, response, and recovery; Industrial disasters and environmental emergencies; Chemical spills and hazardous waste incidents; Community-based disaster management; First aid and basic life support measures; Climate-related disasters and adaptation strategies.

UNIT – VI: CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Environmental, Health and Safety (EHS) Management Systems; ISO 14001 and ISO 45001 Standards; Workplace Mental Health and Well-being; Chemical Safety and REACH Regulations; Occupational Health in the Green Economy; Industrial Disaster Case Studies; Climate Change and Public Health; Sustainable Safety Management Practices.

REFERENCES

1. Goetsch, D.L. (2021). Occupational Safety and Health for Technologists, Engineers and Managers. Pearson Education.
2. Friend, M.A. and Kohn, J.P. (2018). Fundamentals of Occupational Safety and Health. Rowman & Littlefield Publishers.
3. Hughes, P. and Ferrett, E. (2020). Introduction to Health and Safety at Work. Routledge.
4. Salvato, J.A., Nemerow, N.L. and Agardy, F.J. (2003). Environmental Engineering and Sanitation. Wiley Publications.
5. Roughton, J. and Crutchfield, N. (2016). Safety Culture: An Innovative Leadership Approach. Butterworth-Heinemann.
6. Frank P. Lees (2012). Lees' Loss Prevention in the Process Industries. Butterworth-Heinemann.
7. Rao, C.S. (2018). Environmental Pollution Control Engineering. New Age International Publishers.
8. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. (2017). Environmental Engineering. McGraw-Hill Education.
9. World Health Organization (WHO). Environmental Health Guidelines and Reports.
10. International Labour Organization (ILO). Occupational Safety and Health Conventions and Guidelines.
11. Ministry of Labour and Employment, Government of India. Occupational Safety and Health Guidelines.
12. National Disaster Management Authority (NDMA), Government of India Publications.
13. Central Pollution Control Board (CPCB) Safety and Environmental Management Manuals.
14. Environmental Protection Agency (EPA) Occupational and Environmental Health Resources.
15. Sharma, P.D. (2020). Ecology and Environment. Rastogi Publications.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the principles, scope, and significance of Environmental Safety and Health Management, including EHS concepts and occupational health frameworks.
CO2	Identify and classify workplace hazards—physical, chemical, biological, ergonomic, and psychosocial—and describe their routes of exposure and health effects.
CO3	Conduct hazard identification and risk assessment following standard procedures including risk characterization, control hierarchies, and safety sign interpretation.
CO4	Apply appropriate Personal Protective Equipment (PPE) and chemical safety practices in laboratory, industrial, and field environments.
CO5	Analyze causes of industrial accidents, conduct accident investigation and reporting, and implement safety audit and inspection practices.
CO6	Describe fire hazard prevention, electrical safety, chemical safety, and safe laboratory practices essential for occupational safety.
CO7	Understand environmental health determinants—water, air, food—and evaluate vector-borne and waterborne disease management and sanitation practices.
CO8	Develop and evaluate environmental health surveillance, occupational health programmes, and environmental health monitoring strategies for communities.
CO9	Prepare emergency preparedness and disaster management plans for industrial, chemical, and climate-related disasters following the disaster management cycle.
CO10	Evaluate EHS management systems—ISO 14001, ISO 45001—and promote sustainable safety and health practices in professional and community settings.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	2	2	2	2	2	2	1	2
CO3	1	**3**	**3**	**3**	2	2	2	**3**	2	2
CO4	1	2	2	2	**3**	2	2	2	1	1
CO5	2	**3**	**3**	**3**	2	2	2	**3**	2	2
CO6	1	2	2	2	**3**	2	2	2	1	2
CO7	1	**3**	**3**	**3**	2	2	2	2	2	2
CO8	2	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**
CO9	2	**3**	**3**	**3**	2	**3**	**3**	2	2	**3**
CO10	2	**3**	2	2	2	**3**	2	2	1	**3**

FIRST YEAR **SKILL BASED ELECTIVE – I** **SEMESTER II**

VERMICOMPOSTING TECHNOLOGY

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To understand the principles and importance of organic waste management through vermicomposting.
- To gain knowledge about earthworm biology and vermicomposting techniques.
- To develop skills in the production and utilization of vermicompost.
- To promote entrepreneurship opportunities in organic farming and waste management.

UNIT – I

Introduction to Organic Waste Management: Types and sources of biodegradable wastes; Environmental impacts of improper waste disposal; Concept, importance, and advantages of vermicomposting; Scope of vermicomposting in sustainable agriculture.

UNIT – II

Earthworms and Their Role: Classification and biology of earthworms; Ecological categories of earthworms; Common vermicomposting species (Eisenia fetida, Eudriluseugeniae, Perionyx excavatus); Role of earthworms in soil fertility and nutrient cycling.

UNIT – III

Vermicomposting Techniques: Site selection; Vermibeds and vermibins; Raw materials for vermicomposting; Preparation of feedstock; Methods of vermicomposting; Factors affecting vermicomposting – temperature, moisture, pH, aeration, and substrate quality.

UNIT – IV

Production and Quality Assessment: Harvesting and processing of vermicompost; Characteristics of good-quality vermicompost; Nutrient content (NPK); Vermiwash production and applications; Quality control and storage.

UNIT – V

Applications and Entrepreneurship: Use of vermicompost in agriculture, horticulture, and landscaping; Economic aspects of vermicomposting; Small-scale enterprise development; Marketing of vermicompost and vermiwash; Government schemes and support for organic farming.

UNIT – VI CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Organic Farming in India; Natural Farming; Circular Economy and Waste-to-Wealth Initiatives; Urban Composting; Swachh Bharat Mission; Sustainable Agriculture and Soil Health.

REFERENCES

1. Edwards, C.A. and Arancon, N.Q. Vermiculture Technology: Earthworms, Organic Wastes and Environmental Management. CRC Press.
2. Ismail, S.A. Vermicology: The Biology of Earthworms. Orient Longman.
3. Kale, R.D. Earthworms: Nature's Gift for Sustainable Agriculture. Prism Books.
4. Satchel, J.E. Earthworm Ecology. Springer.
5. ICAR Manuals on Organic Farming and Vermicomposting.
6. Ministry of Agriculture and Farmers Welfare Publications.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the principles, importance, and environmental benefits of organic waste management through vermicomposting and its scope in sustainable agriculture.
CO2	Identify and classify common vermicomposting earthworm species—Eisenia fetida, Eudriluseugeniae, Perionyx excavatus—and explain their biological role in soil enrichment.
CO3	Describe the ecological categories of earthworms and explain their contribution to nutrient cycling, soil fertility, and ecosystem productivity.
CO4	Explain the methods, site selection criteria, and construction of vermibeds and vermibins for efficient vermicomposting operations.
CO5	Analyze the key factors influencing vermicompost quality—temperature, moisture, pH, aeration, and substrate composition—and implement control measures.
CO6	Describe the harvesting, processing, and quality assessment of vermicompost including nutrient content analysis (NPK) and storage methods.
CO7	Explain the production and agricultural applications of vermiwash and evaluate its role as a liquid bio-fertilizer in crop management.
CO8	Evaluate the use of vermicompost and vermiwash in agriculture, horticulture, and landscaping and assess their economic advantages over chemical fertilizers.
CO9	Develop entrepreneurial skills in small-scale vermicomposting enterprise development including marketing, branding, and application for government schemes.
CO10	Promote waste-to-resource and circular economy approaches through vermicomposting for sustainable environmental management and community development.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	2	2	1	1	2
CO2	1	**3**	2	1	2	2	2	1	1	2
CO3	1	**3**	2	2	2	2	2	1	1	2
CO4	1	2	2	2	**3**	2	2	2	1	1
CO5	1	2	**3**	**3**	**3**	2	2	2	1	2
CO6	1	2	2	2	**3**	2	2	2	1	1
CO7	1	2	2	2	2	2	2	2	1	2
CO8	1	**3**	**3**	**3**	2	2	2	2	2	2
CO9	2	2	2	2	2	2	2	2	1	2
CO10	**3**	2	2	2	2	**3**	2	2	1	**3**

FIRST YEAR **SKILL BASED ELECTIVE – II** **SEMESTER II**

AQUAPONICS

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To introduce the concept and principles of aquaponics as a sustainable food production system.
- To understand the integration of aquaculture and hydroponics.
- To develop knowledge on aquaponic system design, operation, and maintenance.
- To promote sustainable agriculture, water conservation, and entrepreneurship.

UNIT – I

Introduction to Aquaponics: Concept, history, and principles of aquaponics; Components of aquaponic systems; Advantages and limitations; Aquaponics and sustainable food production; Comparison with conventional agriculture.

UNIT – II

Aquaculture Components: Common fish species used in aquaponics; Fish biology and culture requirements; Water quality parameters; Fish nutrition and feeding practices; Fish health management.

UNIT – III

Hydroponic Components: Principles of hydroponics; Plant growth requirements; Nutrient cycling in aquaponics; Suitable crops for aquaponic cultivation; Plant health and pest management.

UNIT – IV

Aquaponic System Design and Operation: Types of aquaponic systems – Media Bed, Nutrient Film Technique (NFT), Deep Water Culture (DWC); System components and construction; Water circulation and filtration; Monitoring and maintenance.

UNIT – V

Applications and Entrepreneurship: Commercial and household aquaponics; Economic feasibility; Resource efficiency and water conservation; Marketing opportunities; Urban farming and startup potential; Government initiatives supporting sustainable agriculture.

UNIT – VICURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Smart Farming Technologies; Urban Agriculture; Vertical Farming; Climate-Resilient Food Systems; Water-Efficient Agriculture; Sustainable Development Goals and Food Security; Aquaponics Start-ups in India.

REFERENCES

1. Rakocy, J.E., Masser, M.P. and Losordo, T.M. Recirculating Aquaculture Tank Production Systems: Aquaponics.
2. Lennard, W. Aquaponic System Design Parameters. Aquaponic Solutions.
3. Somerville, C., Cohen, M., Pantanella, E., Stankus, A. and Lovatelli, A. Small-Scale Aquaponic Food Production. FAO Fisheries and Aquaculture Technical Paper.
4. Diver, S. Aquaponics – Integration of Hydroponics with Aquaculture. ATTRA Publications.
5. FAO Aquaponics Training Manuals.
6. ICAR Publications on Integrated Farming Systems.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Explain the concept, historical background, and principles of aquaponics as an integrated sustainable food production system.
CO2	Describe the components of aquaponic systems and compare aquaponics with conventional aquaculture and hydroponics in terms of resource efficiency.
CO3	Identify common fish species suitable for aquaponics, understand their culture requirements, water quality needs, and feeding and health management practices.
CO4	Explain the principles of hydroponics, nutrient cycling in aquaponic systems, and identify suitable crops for integrated aquaponic cultivation.
CO5	Describe the design, construction, and operation of different aquaponic system types—Media Bed, NFT, and DWC—and explain water circulation and filtration.
CO6	Monitor basic water quality parameters and system performance indicators essential for maintaining healthy aquaponic production systems.
CO7	Evaluate the environmental benefits of aquaponics in terms of water conservation, sustainable food production, and reduction of agricultural chemical use.
CO8	Assess the economic feasibility, resource efficiency, and commercial potential of aquaponic systems for household and institutional applications.
CO9	Develop entrepreneurial knowledge in urban farming, aquaponics business planning, marketing, and awareness of government initiatives supporting sustainable agriculture.
CO10	Promote aquaponics as a sustainable food system aligned with SDGs, climate-resilient agriculture, and circular economy principles.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	2	2	1	1	2
CO2	1	**3**	**3**	2	2	2	2	2	1	2
CO3	1	**3**	2	2	**3**	2	2	2	1	2
CO4	1	**3**	2	2	**3**	2	2	2	1	2
CO5	1	**3**	2	2	**3**	2	2	2	1	1
CO6	1	2	**3**	**3**	**3**	2	2	**3**	1	2
CO7	1	**3**	**3**	2	2	2	2	2	1	2
CO8	1	**3**	**3**	**3**	2	2	2	2	1	2
CO9	2	2	2	2	2	2	2	2	1	2
CO10	2	2	2	2	2	**3**	2	2	1	**3**

SECOND YEAR **SKILL BASED ELECTIVE – III** **SEMESTER III**

RAINWATER HARVESTING

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To understand the importance of rainwater harvesting for water conservation and sustainable water management.
- To gain knowledge about various rainwater harvesting techniques and structures.
- To develop skills in planning, designing, and maintaining rainwater harvesting systems.
- To create awareness about groundwater recharge and water security.

UNIT – I

Introduction to Water Resources: Global and national water resources; Water scarcity and water stress; Importance of water conservation; Need for rainwater harvesting; Traditional water harvesting systems in India.

UNIT – II

Principles of Rainwater Harvesting: Hydrological cycle and precipitation; Surface runoff and infiltration; Concepts and objectives of rainwater harvesting; Benefits and limitations of rainwater harvesting.

UNIT – III

Rainwater Harvesting Techniques: Rooftop rainwater harvesting; Surface runoff harvesting; Recharge pits, recharge trenches, recharge wells, percolation ponds, farm ponds, and check dams; Urban and rural rainwater harvesting systems.

UNIT – IV

Design and Installation of Rainwater Harvesting Systems: Components of rainwater harvesting systems; Catchment area, conveyance system, filtration unit, storage structures; Estimation of water harvesting potential; Maintenance and monitoring.

UNIT – V

Applications and Sustainable Water Management: Groundwater recharge; Community-based water conservation; Rainwater harvesting in institutions and residential buildings; Government policies and schemes; Case studies of successful rainwater harvesting projects.

UNIT – VI CURRENT CONTOURS ***(For Continuous Internal Assessment Only)***

Jal Shakti Abhiyan; Atal Bhujal Yojana; Urban Water Security; Climate Change and Water Conservation; Smart Water Management; Nature-Based Solutions for Water Sustainability.

REFERENCES

1. Agarwal, A. and Narain, S. Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems. Centre for Science and Environment.
2. Gould, J. and Nissen-Petersen, E. Rainwater Catchment Systems for Domestic Supply. Intermediate Technology Publications.
3. Thomas, T. Rainwater Harvesting for Human Survival. International Book Distributors.
4. Ministry of Jal Shakti, Government of India Publications.
5. Centre for Science and Environment (CSE) Manuals on Rainwater Harvesting.
6. UNEP Water Conservation Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the importance of rainwater harvesting in addressing water scarcity and contributing to sustainable water resource management at local and national levels.
CO2	Explain traditional water harvesting systems of India and describe their ecological, cultural, and hydrological significance.
CO3	Describe the hydrological cycle, precipitation patterns, surface runoff, and infiltration processes that govern rainwater availability and harvesting potential.
CO4	Identify and explain various rainwater harvesting techniques—rooftop harvesting, percolation ponds, recharge pits, check dams, and farm ponds.
CO5	Differentiate between urban and rural rainwater harvesting systems and explain their respective design requirements and applications.
CO6	Estimate rainwater harvesting potential for specific locations based on catchment area, rainfall data, and system efficiency parameters.
CO7	Describe the components—catchment area, conveyance system, filtration unit, and storage structures—and explain principles of installation and maintenance.
CO8	Evaluate the role of rainwater harvesting in groundwater recharge and long-term water security for communities and institutions.
CO9	Analyze national schemes and government policies—Jal Shakti Abhiyan, Atal Bhujal Yojana—supporting rainwater harvesting and sustainable water management.
CO10	Promote community-based water conservation practices and develop awareness of smart water management solutions for climate-resilient water security.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	2	2	1	1	2
CO2	1	2	2	2	2	2	2	1	1	2
CO3	1	**3**	2	2	**3**	2	2	2	1	2
CO4	1	**3**	2	2	2	2	2	1	1	1
CO5	1	**3**	2	2	2	2	2	1	1	1
CO6	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	**3**	2	2	**3**	2	2	2	1	1
CO8	1	**3**	**3**	**3**	2	2	2	2	2	2
CO9	2	2	2	2	2	**3**	2	2	1	2
CO10	**3**	2	2	2	2	**3**	2	2	1	**3**

SECOND YEAR **SKILL BASED ELECTIVE – IV** **SEMESTER III**

CARBON BUDGETING

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To introduce the concept of carbon budgeting and carbon accounting.
- To understand carbon sources, sinks, and the global carbon cycle.
- To develop skills for estimating carbon footprints and greenhouse gas emissions.
- To create awareness about climate change mitigation and carbon management strategies.

UNIT – I

Introduction to Carbon and Climate Change: Carbon cycle and carbon reservoirs; Greenhouse gases and global warming; Climate change and its impacts; Concept of carbon neutrality and net-zero emissions.

UNIT – II

Carbon Sources and Carbon Sinks: Natural and anthropogenic sources of carbon emissions; Fossil fuel combustion; Land use and land cover changes; Forests, wetlands, and oceans as carbon sinks; Carbon sequestration.

UNIT – III

Principles of Carbon Budgeting: Carbon footprint and carbon accounting; Components of carbon budgeting; Carbon inventory; Measurement units and emission factors; Scope 1, Scope 2, and Scope 3 emissions.

UNIT – IV

Carbon Estimation and Assessment: Estimation of carbon emissions from transportation, energy consumption, and waste generation; Calculation of personal, household, and institutional carbon footprints; Introduction to carbon calculators and assessment tools.

UNIT – V

Carbon Management and Mitigation: Carbon offsetting; Carbon credits and carbon trading; Renewable energy and energy efficiency; Nature-based solutions; Sustainable lifestyles and low-carbon development strategies.

UNIT – VI CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

India's Net Zero Commitment; Carbon Markets; Green Buildings; Carbon-Neutral Campuses; Blue Carbon Ecosystems; Corporate Carbon Disclosure; Climate Action and Sustainable Development Goals.

REFERENCES

1. IPCC Assessment Reports on Climate Change.
2. Berners-Lee, M. How Bad Are Bananas? The Carbon Footprint of Everything. Profile Books.
3. Wiedmann, T. and Minx, J. A Definition of Carbon Footprint. Ecological Economics Research Trends.
4. UNEP Emissions Gap Reports.
5. Ministry of Environment, Forest and Climate Change (MoEFCC) Publications.
6. World Resources Institute (WRI) Greenhouse Gas Protocol Guides.
7. Intergovernmental Panel on Climate Change (IPCC) Carbon Accounting Guidelines.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the fundamentals of carbon budgeting and carbon accounting and explain their role in climate change monitoring and management.
CO2	Explain the global carbon cycle, carbon reservoirs, greenhouse gases, and their contribution to global warming and climate change.
CO3	Identify natural and anthropogenic sources of carbon emissions—fossil fuel combustion, land use change—and recognize forests, wetlands, and oceans as carbon sinks.
CO4	Explain the principles of carbon footprint calculation, carbon inventory development, and the distinction between Scope 1, 2, and 3 emissions.
CO5	Estimate carbon emissions from transportation, energy consumption, and waste generation at personal, household, and institutional levels.
CO6	Apply carbon calculators and assessment tools to measure and compare carbon footprints across different activities and sectors.
CO7	Evaluate carbon management strategies—offsetting, carbon credits, carbon trading, renewable energy adoption, and nature-based solutions.
CO8	Assess India's net zero commitments, carbon market developments, corporate carbon disclosure, and green building practices.
CO9	Promote low-carbon lifestyles including sustainable consumption, energy conservation, and climate-conscious decision-making in daily life.
CO10	Develop awareness of circular carbon economy concepts—blue carbon ecosystems, bioenergy, sustainable agriculture—and their role in global climate mitigation.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	2	2	2	2	1	1	2
CO2	1	3	2	2	3	2	2	1	1	2
CO3	1	3	2	2	2	2	2	1	1	2
CO4	1	3	2	2	3	2	2	2	1	2
CO5	1	2	3	3	3	2	2	3	2	2
CO6	1	2	3	3	3	3	2	3	2	2
CO7	1	3	3	3	2	2	2	2	2	2
CO8	2	3	3	2	2	3	3	2	2	3
CO9	3	2	2	2	2	3	2	2	1	3
CO10	2	3	3	2	2	3	3	2	2	3

SECOND YEAR **SKILL BASED ELECTIVE – V** **SEMESTER IV**

CIRCULAR ECONOMY

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To introduce the principles and concepts of the circular economy.
- To understand resource efficiency, waste minimization, and sustainable production systems.
- To develop knowledge on circular business models and resource recovery strategies.
- To promote sustainable consumption and environmental stewardship.

UNIT – I

Introduction to Circular Economy: Definition, principles, and evolution of circular economy; Linear economy versus circular economy; Resource scarcity and sustainable development; Circular economy and Sustainable Development Goals (SDGs).

UNIT – II

Resource Efficiency and Waste Minimization: Concepts of Reduce, Reuse, Recycle, Recover, and Refurbish (5Rs); Material flow analysis; Resource conservation; Industrial ecology; Life cycle thinking.

UNIT – III

Circular Business Models: Product life extension; Sharing economy; Product-as-a-service model; Green entrepreneurship; Sustainable supply chains; Eco-industrial parks and industrial symbiosis.

UNIT – IV

Waste-to-Resource Technologies: Composting, vermicomposting, biomethanation, recycling technologies; Material Recovery Facilities (MRFs); Urban mining and biomining; Resource recovery from municipal solid waste, e-waste, and construction waste.

UNIT – V

Applications and Policy Framework: Circular economy practices in agriculture, manufacturing, and urban systems; Circular economy policies in India; Extended Producer Responsibility (EPR); Case studies of successful circular economy initiatives.

UNIT – VI CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Plastic Waste Management Rules; Circular Economy Action Plans; Green Manufacturing; Zero Waste Cities; Resource-Efficient and Cleaner Production (RECP); ESG and Circular Economy; Circular Economy in India.

REFERENCES

1. Ellen MacArthur Foundation. Towards the Circular Economy.
2. Stahel, W.R. The Circular Economy: A User's Guide. Routledge.
3. Lacy, P. and Rutqvist, J. Waste to Wealth: The Circular Economy Advantage. Palgrave Macmillan.
4. Kirchherr, J., Reike, D. and Hekkert, M. Conceptualizing the Circular Economy. Resources, Conservation and Recycling.
5. Ministry of Environment, Forest and Climate Change (MoEFCC) Publications.
6. Centre for Science and Environment (CSE) Reports on Waste Management.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the definition, principles, evolution, and significance of the circular economy and differentiate it from the conventional linear economy model.
CO2	Explain the relationship between circular economy, resource scarcity, and sustainable development goals at national and global levels.
CO3	Apply the concepts of Reduce, Reuse, Recycle, Recover, and Refurbish (5Rs) to analyze material flows and resource conservation strategies.
CO4	Describe material flow analysis, industrial ecology, life cycle thinking, and their role in designing resource-efficient systems.
CO5	Identify and evaluate circular business models—product life extension, sharing economy, product-as-a-service, eco-industrial parks—for sustainable production.
CO6	Analyze waste-to-resource technologies including composting, biomethanation, recycling, Material Recovery Facilities (MRF), and urban mining.
CO7	Evaluate resource recovery approaches for municipal solid waste, e-waste, and construction waste within the circular economy framework.
CO8	Analyze circular economy practices in agriculture, manufacturing, and urban systems and examine relevant Indian and global policy frameworks.
CO9	Assess Extended Producer Responsibility (EPR) regulations and examine case studies of successful circular economy initiatives from India and abroad.
CO10	Promote sustainable consumption, resource conservation, and environmentally responsible practices aligned with circular economy principles.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	2	2	2	2	1	1	2
CO2	1	3	2	2	2	2	2	1	1	2
CO3	1	3	3	3	2	2	2	2	1	2
CO4	1	3	2	2	3	2	2	2	2	2
CO5	1	3	3	3	2	2	2	2	1	2
CO6	1	3	3	3	3	2	2	3	2	2
CO7	1	3	3	3	2	2	2	2	2	2
CO8	2	3	3	3	2	3	3	2	2	2
CO9	2	3	3	3	2	3	3	2	2	2
CO10	3	3	2	2	2	3	2	2	1	3

SECOND YEAR SKILL ENHANCEMENT COURSE – VI SEMESTER IV

ECO-FRIENDLY PRODUCTS

Code (Theory) Credit: 2

COURSE OBJECTIVES

- To introduce eco-friendly products and their role in environmental sustainability.
- To understand the principles of green product design and sustainable production.
- To develop knowledge on environmentally responsible consumer choices.
- To encourage entrepreneurship in the development and marketing of eco-friendly products.

UNIT – I

Introduction to Eco-Friendly Products: Concept and importance; Environmental impacts of conventional products; Green consumerism; Sustainable production and consumption; Eco-labeling and environmental certification.

UNIT – II

Natural and Biodegradable Products: Biodegradable materials; Natural fibers and products; Bamboo-based products; Areca leaf products; Coir products; Jute products; Organic personal care products and natural dyes.

UNIT – III

Eco-Friendly Alternatives to Conventional Products: Alternatives to single-use plastics; Reusable bags, containers, and packaging materials; Compostable products; Sustainable household products; Green office supplies.

UNIT – IV

Green Product Development and Manufacturing: Principles of eco-design; Product life cycle assessment; Sustainable packaging; Resource-efficient manufacturing; Quality standards and environmental certification.

UNIT – V

Entrepreneurship and Marketing: Small-scale production of eco-friendly products; Business opportunities; Marketing strategies; Branding and eco-labeling; Government schemes supporting green enterprises; Success stories of eco-friendly startups.

UNIT – VI CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Plastic-Free Campaigns; Green Startups in India; Sustainable Fashion; Eco-Friendly Packaging Innovations; Bio-based Products; Circular Product Design; Responsible Consumption and Production (SDG 12).

REFERENCES

1. Charter, M. and Tischner, U. Sustainable Solutions: Developing Products and Services for the Future. Greenleaf Publishing.
2. Vezzoli, C. Design for Environmental Sustainability. Springer.
3. Papanek, V. Design for the Real World: Human Ecology and Social Change. Thames & Hudson.
4. Ministry of MSME Publications on Green Enterprises.
5. United Nations Environment Programme (UNEP) Reports on Sustainable Consumption and Production.
6. Government of India Publications on Eco-labeling and Green Products.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the significance of eco-friendly products in reducing environmental impacts and advancing sustainable production and consumption practices.
CO2	Identify and classify natural and biodegradable product alternatives—bamboo, areca leaf, coir, jute, organic textiles—and explain their ecological advantages.
CO3	Explain eco-labeling systems, environmental certifications, and green consumerism principles in supporting sustainable market choices.
CO4	Describe eco-friendly alternatives to single-use plastics including reusable bags, compostable containers, and sustainable packaging materials.
CO5	Apply principles of eco-design and life cycle assessment (LCA) to evaluate the environmental footprint of product development and manufacturing.
CO6	Understand resource-efficient manufacturing, quality standards, and environmental certification processes relevant to green product industries.
CO7	Evaluate the environmental and economic benefits of eco-friendly products compared to conventional products across multiple sectors.
CO8	Analyze current trends in sustainable fashion, bio-based products, circular product design, and plastic-free initiatives in India and globally.
CO9	Develop entrepreneurial skills for small-scale production, marketing, and branding of eco-friendly products supported by government green enterprise schemes.
CO10	Promote responsible consumption, eco-conscious lifestyles, and sustainable development aligned with SDG 12 on sustainable production and consumption.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	2	2	2	2	1	1	2
CO2	1	3	2	2	2	2	2	1	1	2
CO3	2	3	2	2	2	2	2	1	1	2
CO4	1	3	2	2	2	2	2	1	1	2
CO5	1	3	3	3	3	2	2	2	2	2
CO6	1	2	2	2	3	2	2	2	1	1
CO7	1	3	3	3	2	2	2	2	2	2
CO8	2	3	3	2	2	3	3	2	2	3
CO9	2	2	2	2	2	2	2	2	1	2
CO10	3	2	2	2	2	3	2	2	1	3

SECOND YEAR **SKILL BASED ELECTIVE – VII** **SEMESTER V**

INTELLECTUAL PROPERTY RIGHTS

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To introduce the concepts and significance of Intellectual Property Rights (IPR).
- To understand different forms of intellectual property protection and their applications.
- To develop awareness of innovation, creativity, and legal protection of intellectual assets.
- To familiarize students with IPR issues related to biodiversity, traditional knowledge, and environmental technologies.

UNIT – I

Introduction to Intellectual Property Rights: Definition, concept, and importance of IPR; Evolution of IPR; Role of IPR in innovation, research, and economic development; Intellectual property and knowledge economy.

UNIT – II

Types of Intellectual Property Rights: Patents, Copyrights, Trademarks, Industrial Designs, Geographical Indications (GI), Trade Secrets, and Plant Variety Protection; Features, scope, and duration of protection.

UNIT – III

Patent System and Innovation: Patentable and non-patentable inventions; Patent application process; Patent search and documentation; Technology transfer and commercialization; Case studies on patents and innovations.

UNIT – IV

IPR and Biodiversity: Biodiversity and intellectual property; Traditional knowledge and biopiracy; Access and Benefit Sharing (ABS); Protection of indigenous knowledge systems; Biological Diversity Act and related provisions.

UNIT – V

IPR Management and Entrepreneurship: Intellectual property management; Licensing and technology transfer; Start-ups and innovation ecosystems; IPR in environmental technologies and green innovations; Role of IPR in sustainable development.

UNIT – VI CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Traditional Knowledge Digital Library (TKDL); Geographical Indications in India; Green Patents; Open Innovation; Artificial Intelligence and IPR; Biodiversity Conservation and Benefit Sharing; Intellectual Property in the Bioeconomy.

REFERENCES

1. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill.
2. Narayanan, P. Intellectual Property Law. Eastern Law House.
3. Cornish, W. and Llewelyn, D. Intellectual Property: Patents, Copyrights, Trademarks and Allied Rights. Sweet & Maxwell.
4. WIPO Publications on Intellectual Property Rights.
5. World Trade Organization (WTO) – TRIPS Agreement Documents.
6. National Intellectual Property Rights Policy, Government of India.
7. Biological Diversity Act, 2002 and National Biodiversity Authority Publications.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the definition, concept, and significance of Intellectual Property Rights (IPR) and their role in fostering innovation, research, and economic development.
CO2	Distinguish the major types of intellectual property—patents, copyrights, trademarks, GI, industrial designs, trade secrets, plant variety protection—and their features.
CO3	Explain the criteria for patentability, the patent application process, patent search and documentation, and the relationship between patents and technology transfer.
CO4	Analyze case studies of innovations and patents relevant to environmental science, green technologies, and sustainable development.
CO5	Describe the relationship between IPR and biodiversity, including traditional knowledge, biopiracy, Access and Benefit Sharing (ABS), and related legislation.
CO6	Explain the Biological Diversity Act provisions relevant to IPR, indigenous knowledge systems, and protection of biodiversity-related intellectual assets.
CO7	Apply IPR concepts in the context of green innovations, environmental technologies, and sustainable development entrepreneurship.
CO8	Analyze the Traditional Knowledge Digital Library (TKDL), Geographical Indications of India, and their role in protecting indigenous environmental knowledge.
CO9	Develop skills in intellectual property management including licensing, technology transfer, and building start-ups within innovation ecosystems.
CO10	Appreciate the role of IPR in sustainable development, circular economy, knowledge management, and the global bioeconomy.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	2	2	2	2	2	1	1	2
CO3	1	**3**	**3**	2	2	2	2	2	2	2
CO4	1	**3**	**3**	**3**	2	2	2	2	2	2
CO5	1	**3**	**3**	2	2	2	2	2	2	2
CO6	2	**3**	2	2	2	**3**	2	1	1	2
CO7	1	**3**	**3**	2	2	**3**	2	2	2	**3**
CO8	2	**3**	**3**	2	2	**3**	**3**	2	2	2
CO9	2	2	2	2	2	2	2	2	2	2
CO10	2	**3**	2	2	2	**3**	2	2	2	**3**

SECOND YEAR SKILL ENHANCEMENT COURSE – VIII SEMESTER V

ENVIRONMENTAL QUALITY ASSESSMENT

Code (Theory) Credit: 2

COURSE OBJECTIVES

- To introduce the principles of environmental quality assessment and monitoring.
- To understand the indicators and standards used for assessing environmental quality.
- To develop skills in environmental data collection, interpretation, and reporting.
- To familiarize students with environmental monitoring techniques used in air, water, soil, and noise quality assessment.

UNIT – I

Introduction to Environmental Quality Assessment: Concept and significance; Environmental quality indicators; Environmental standards and guidelines; Environmental monitoring and assessment framework.

UNIT – II

Air Quality Assessment: Sources of air pollution; Ambient air quality monitoring; Air Quality Index (AQI); Particulate matter and gaseous pollutants; National Ambient Air Quality Standards (NAAQS); Interpretation of air quality data.

UNIT – III

Water Quality Assessment: Water quality parameters – physical, chemical, and biological; Water Quality Index (WQI); Drinking water standards; Surface water and groundwater quality assessment; Water sampling and monitoring techniques.

UNIT – IV

Soil and Noise Quality Assessment: Soil quality indicators; Soil contamination and assessment methods; Noise pollution and measurement; Noise quality standards; Environmental implications of degraded soil and noise pollution.

UNIT – V

Environmental Monitoring Tools and Reporting: Environmental sampling techniques; Field and laboratory monitoring methods; Data recording and interpretation; Environmental audit and reporting; Use of GIS and digital tools in environmental assessment.

UNIT – VI CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Smart Environmental Monitoring Systems; Low-Cost Sensors for Environmental Assessment; Citizen Science and Environmental Monitoring; Real-Time Air Quality Monitoring; Environmental Data Analytics; ESG Reporting and Sustainability Indicators.

REFERENCES

1. Rao, C.S. Environmental Pollution Control Engineering. New Age International Publishers.
2. APHA. Standard Methods for the Examination of Water and Wastewater.
3. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. Environmental Engineering. McGraw-Hill.
4. Trivedi, R.K. and Goel, P.K. Environmental Pollution Studies. Environmental Publications.
5. Central Pollution Control Board (CPCB) Manuals and Guidelines.
6. UNEP Environmental Monitoring and Assessment Reports.
7. World Health Organization (WHO) Environmental Quality Guidelines.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the concepts, significance, and framework of environmental quality assessment and identify major environmental quality indicators.
CO2	Explain national and international environmental standards and guidelines for air, water, soil, and noise quality monitoring.
CO3	Describe sources, types, and effects of air pollution and explain the Air Quality Index (AQI), National Ambient Air Quality Standards (NAAQS), and interpretation of air quality data.
CO4	Explain water quality parameters—physical, chemical, and biological—and apply the Water Quality Index (WQI) to assess drinking and surface water quality.
CO5	Describe soil quality indicators and soil contamination assessment methods and evaluate the environmental significance of soil degradation.
CO6	Understand noise pollution measurement, noise quality standards, and assessment of environmental noise impacts on human health and wildlife.
CO7	Apply environmental sampling techniques and field and laboratory monitoring methods for systematic environmental quality data collection.
CO8	Interpret environmental monitoring data, quality indices, and reporting formats used for environmental audit and compliance assessment.
CO9	Use GIS, digital tools, and smart sensor technologies for advanced environmental monitoring, data analytics, and quality assessment reporting.
CO10	Apply environmental quality assessment findings to support evidence-based environmental management, regulatory compliance, and sustainable decision-making.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	**3**	2	2	2	2	2	1	1	2
CO2	1	**3**	2	2	2	2	2	1	1	2
CO3	1	**3**	**3**	**3**	**3**	2	2	**3**	2	2
CO4	1	**3**	2	**3**	**3**	2	2	**3**	2	2
CO5	1	**3**	2	2	2	2	2	2	1	2
CO6	1	2	2	2	**3**	2	2	2	1	1
CO7	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO8	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO9	1	2	**3**	**3**	**3**	**3**	**3**	**3**	2	2
CO10	2	**3**	**3**	**3**	2	**3**	**3**	**3**	2	**3**

FIRST YEAR INTERDISCIPLINARY COURSE – I SEMESTER I

ENVIRONMENTAL EDUCATION FOR SUSTAINABILITY

Code (Theory) Credit: 2

COURSE OBJECTIVES

- To introduce the concepts and principles of environmental education and sustainability.
- To develop environmental awareness and responsible citizenship.
- To understand environmental issues and their relationship with sustainable development.
- To promote sustainable lifestyles and environmental stewardship.

UNIT – I

Introduction to Environment and Sustainability: Concept of environment; Components of environment; Environmental issues and challenges; Sustainable development and its goals; Role of environmental education in sustainability.

UNIT – II

Natural Resources and Conservation: Forest, water, land, mineral, and energy resources; Resource depletion; Conservation and sustainable utilization of natural resources.

UNIT – III

Environmental Problems and Solutions: Pollution, climate change, biodiversity loss, deforestation, and waste generation; Sustainable solutions and mitigation measures.

UNIT – IV

Environmental Ethics and Sustainable Lifestyles: Environmental ethics; Responsible consumption; Green practices; Sustainable communities; Role of individuals in environmental protection.

UNIT – V

Environmental Education and Public Participation: Environmental awareness programmes; Community participation; Environmental movements; Environmental communication and advocacy.

UNIT –VI CURRENT CONTOURS *(For Continuous Internal Assessment Only)*

Sustainable Development Goals (SDGs); Mission LiFE (Lifestyle for Environment); Climate Action; Green Campuses; Youth Participation in Sustainability.

REFERENCES

1. Bharucha, E. Textbook of Environmental Studies. Universities Press.
2. Palmer, J. Environmental Education in the 21st Century. Routledge.
3. UNESCO. Education for Sustainable Development Resources.
4. Cunningham, W.P. and Cunningham, M.A. Environmental Science: A Global Concern.
5. UNEP Environmental Education Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the concept of environment, its components, and the principles and significance of environmental education for sustainable development.
CO2	Explain major environmental challenges—pollution, climate change, biodiversity loss, deforestation, and waste—and their relationship with sustainable development.
CO3	Identify and describe sustainable natural resource management practices for forests, water, land, minerals, and energy resources.
CO4	Apply principles of environmental ethics and responsible consumption to adopt green practices and sustainable lifestyles in daily life.

CO No.	Course Outcome
CO5	Understand the significance of environmental education programmes, community participation, and environmental movements in promoting public awareness.
CO6	Explain the Sustainable Development Goals (SDGs) and relate them to environmental education, climate action, and sustainable living.
CO7	Develop communication skills for environmental advocacy, community engagement, and promoting environmental stewardship at individual and group levels.
CO8	Participate actively in environmental conservation and awareness activities such as green campus initiatives and youth sustainability programs.
CO9	Evaluate the role of Mission LiFE (Lifestyle for Environment) and similar national frameworks in encouraging sustainable lifestyle changes.
CO10	Develop a sense of environmental responsibility and commitment to sustainable development as informed and engaged citizens.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	2	2	1	1	2
CO2	1	2	**3**	2	2	2	2	2	1	2
CO3	1	2	2	2	2	2	2	1	1	2
CO4	**3**	2	2	2	2	**3**	2	1	1	**3**
CO5	**3**	2	2	2	2	**3**	2	1	1	2
CO6	2	2	2	2	2	**3**	2	1	1	**3**
CO7	**3**	2	2	2	2	**3**	2	1	1	2
CO8	**3**	2	2	1	1	**3**	**3**	1	1	**3**
CO9	2	2	2	2	2	**3**	2	1	1	**3**
CO10	**3**	2	2	2	2	**3**	**3**	2	1	**3**

FIRST YEAR **INTERDISCIPLINARY COURSE – II** **SEMESTER II**

ENVIRONMENT AND HEALTH

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To understand the relationship between environment and human health.
- To study environmental factors affecting public health.
- To create awareness about environmental diseases and preventive measures.
- To promote healthy and sustainable living practices.

UNIT – I

Introduction to Environmental Health: Concept and scope; Environmental determinants of health; Human health and ecosystem health; Public health and environmental quality.

UNIT – II

Air, Water, and Food Quality: Air pollution and health effects; Water quality and waterborne diseases; Food contamination and food safety; Environmental sanitation.

UNIT – III

Environmental Diseases: Communicable and non-communicable diseases; Vector-borne diseases; Occupational health hazards; Emerging environmental health issues.

UNIT – IV

Waste Management and Health: Solid waste, biomedical waste, e-waste, and plastic waste; Health impacts of improper waste disposal; Waste management practices.

UNIT – V

Health Promotion and Environmental Protection: Healthy lifestyle practices; Environmental hygiene; Community health programmes; Role of government and public participation.

UNIT – VI CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

One Health Concept; Climate Change and Health; Air Quality and Public Health; Microplastics and Human Health; Environmental Health Surveillance.

REFERENCES

1. Friis, R.H. Essentials of Environmental Health.
2. WHO Environmental Health Guidelines.
3. Park, K. Preventive and Social Medicine.
4. Salvato, J.A. Environmental Engineering and Sanitation.
5. UNEP and WHO Environmental Health Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the relationship between environment and human health, including the scope of environmental health and concept of ecosystem health.
CO2	Identify environmental determinants of health—air, water, food, soil—and explain how environmental quality influences public health outcomes.
CO3	Describe the effects of air pollution, water contamination, and food safety issues on human health and explain preventive measures.
CO4	Analyze communicable and non-communicable diseases caused by environmental factors, including vector-borne diseases and occupational hazards.
CO5	Evaluate the impacts of solid waste, biomedical waste, e-waste, and plastic waste on human health and explain waste management solutions.

CO No.	Course Outcome
CO6	Explain waterborne disease transmission, environmental sanitation practices, and the role of safe water supply in public health protection.
CO7	Assess emerging environmental health issues including microplastics in the human body, climate change-related health risks, and air quality impacts.
CO8	Understand the One Health concept and explain the interconnection between human health, animal health, and ecosystem health.
CO9	Promote community awareness regarding environmental hygiene, healthy lifestyle practices, and participation in government health programs.
CO10	Evaluate environmental health risks, develop management strategies, and foster responsibility for sustainable and health-conscious living.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	2	2	2	1	1	2
CO2	1	2	3	2	2	2	2	2	1	2
CO3	1	2	3	2	2	2	2	2	1	2
CO4	1	2	3	2	2	2	2	2	1	2
CO5	1	2	3	2	2	2	2	2	1	2
CO6	1	2	2	2	2	2	2	2	1	2
CO7	2	2	3	2	2	3	3	2	2	3
CO8	1	2	2	2	2	2	2	1	1	2
CO9	3	2	2	1	1	3	2	1	1	2
CO10	2	2	3	3	2	3	3	2	2	3

SECOND YEAR **INTERDISCIPLINARY COURSE – III** **SEMESTER III**

GREEN AUDITING

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To introduce the concepts and importance of green auditing.
- To understand environmental performance assessment and sustainability indicators.
- To develop skills in resource auditing and environmental reporting.
- To promote sustainable campus and organizational practices.

UNIT – I

Introduction to Green Auditing: Concept, objectives, scope, and significance; Types of environmental audits; Green campus initiatives; Sustainability assessment.

UNIT – II

Energy Audit: Energy consumption patterns; Energy efficiency; Renewable energy use; Carbon footprint assessment; Energy conservation measures.

UNIT – III

Water Audit: Water use assessment; Water conservation measures; Rainwater harvesting; Wastewater management; Water-use efficiency.

UNIT – IV

Waste Audit: Waste generation and characterization; Waste segregation; Recycling and resource recovery; Circular economy concepts; Waste minimization.

UNIT – V

Biodiversity and Green Campus Audit: Green cover assessment; Biodiversity documentation; Sustainable transportation; Green procurement; Environmental reporting.

UNIT – VI CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Green Ranking of Institutions; Carbon Neutral Campuses; ESG Reporting; Sustainable Campus Management; Smart Resource Monitoring Systems.

REFERENCES

1. UNEP Environmental Audit Guidelines.
2. ISO 14001 Environmental Management Systems Manuals.
3. CPCB Environmental Audit Guidelines.
4. CSE Publications on Green Campuses.
5. MoEFCC Environmental Management Resources.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the concept, objectives, scope, and significance of green auditing as a tool for environmental performance assessment.
CO2	Identify and differentiate types of environmental audits and explain their role in promoting sustainability in organizations and institutions.
CO3	Conduct a basic energy audit by assessing energy consumption patterns, identifying energy-saving opportunities, and calculating carbon footprints.
CO4	Evaluate renewable energy use, energy efficiency measures, and energy conservation strategies applicable to campus and institutional settings.
CO5	Perform a water audit by assessing water use patterns, identifying wasteful practices, and recommending conservation and harvesting measures.
CO6	Conduct a waste audit to characterize waste generation, promote waste segregation, resource

CO No.	Course Outcome
	recovery, and circular economy principles.
CO7	Assess biodiversity and green cover in institutional settings through biodiversity documentation and environmental reporting.
CO8	Interpret sustainability indicators and audit reports to recommend practical measures for improving the environmental performance of organizations.
CO9	Understand ESG reporting, green ranking systems, and carbon neutrality frameworks applicable to educational institutions and enterprises.
CO10	Promote sustainable campus management, green procurement, and smart resource monitoring systems for environmental excellence.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	2	2	2	1	1	2
CO2	1	2	2	2	2	2	2	1	1	2
CO3	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO4	1	2	**3**	2	2	2	2	2	1	2
CO5	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO6	1	2	**3**	**3**	**3**	2	2	**3**	2	2
CO7	1	2	**3**	2	2	2	2	2	2	2
CO8	2	2	**3**	**3**	2	**3**	**3**	2	2	2
CO9	2	2	2	2	2	**3**	2	1	1	2
CO10	**3**	2	2	2	2	**3**	2	2	1	**3**

SECOND YEAR **INTERDISCIPLINARY COURSE – IV** **SEMESTER IV**

MARINE POLLUTION

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES

- To understand the sources, types, and impacts of marine pollution.
- To study the effects of pollutants on marine ecosystems and biodiversity.
- To create awareness about marine conservation and sustainable ocean management.
- To understand national and international efforts for marine pollution control.

UNIT – I

Introduction to Marine Environment: Oceans and seas; Marine ecosystems and biodiversity; Importance of marine resources; Coastal and marine environments.

UNIT – II

Sources and Types of Marine Pollution: Land-based and sea-based sources; Oil pollution; Plastic pollution; Sewage and industrial discharges; Agricultural runoff; Thermal and radioactive pollution.

UNIT – III

Impacts of Marine Pollution: Effects on marine organisms; Coral reef degradation; Eutrophication; Bioaccumulation and biomagnification; Impacts on fisheries and coastal communities.

UNIT – IV

Marine Pollution Monitoring and Control: Marine water quality assessment; Pollution monitoring techniques; Waste management in coastal regions; Oil spill management and response.

UNIT – V

Marine Conservation and Sustainable Ocean Management: Marine protected areas; Coastal zone management; Blue economy; Ocean governance; Community participation in marine conservation.

UNIT – VI CURRENT CONTOURS*(For Continuous Internal Assessment Only)*

Marine Plastic Debris; Microplastics in Oceans; Blue Carbon Ecosystems; Sustainable Fisheries; UN Decade of Ocean Science; Marine Biodiversity Conservation.

REFERENCES

1. Clark, R.B. Marine Pollution.
2. Kennish, M.J. Practical Handbook of Marine Science.
3. UNEP Marine Pollution Reports.
4. NOAA Marine Conservation Resources.
5. United Nations Ocean and Climate Reports.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome
CO1	Understand the structure and significance of the marine environment including oceans, coastal ecosystems, marine biodiversity, and marine resources.
CO2	Identify and explain land-based and sea-based sources of marine pollution including oil spills, plastic debris, sewage, industrial discharge, and agricultural runoff.
CO3	Analyze the effects of marine pollution on marine organisms, coral reefs, and overall marine ecosystem functioning.
CO4	Describe the processes of eutrophication, bioaccumulation, and biomagnification in marine ecosystems and their cascading impacts on fisheries and food chains.
CO5	Evaluate monitoring techniques and methodologies used for assessing marine water quality and pollution levels in coastal environments.

CO No.	Course Outcome
CO6	Describe oil spill management strategies, waste management practices in coastal regions, and pollution response mechanisms.
CO7	Understand the concept and significance of Marine Protected Areas (MPAs) and their role in marine biodiversity conservation.
CO8	Analyze blue economy principles, coastal zone management strategies, and ocean governance frameworks for sustainable marine resource use.
CO9	Explain the role of community participation, international conventions—UNCLOS, MARPOL—and national policies in marine pollution control.
CO10	Evaluate emerging marine pollution issues—microplastics in oceans, blue carbon ecosystems, sustainable fisheries—and support ocean conservation.

CO-PO Mapping

Mapping Level: 3 = High | 2 = Medium | 1 = Low

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	2	2	2	1	1	2
CO2	1	2	3	2	2	2	2	2	1	2
CO3	1	2	3	2	2	2	2	2	1	2
CO4	1	2	3	3	2	2	2	2	2	2
CO5	1	2	3	3	3	2	2	3	2	2
CO6	1	2	3	2	2	2	2	2	1	2
CO7	1	2	2	2	2	2	2	1	1	2
CO8	1	2	2	2	2	2	2	2	1	2
CO9	2	2	2	2	2	3	2	1	1	2
CO10	2	2	3	2	2	3	3	2	2	3