पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।
NAAC Accredited-2015
'B' Grade (CGPA 2.62)

# PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

## FACULTY: Science and Technology

## Syllabus of

## Bachelor of Science (B.Sc.) Part - II

## ENVIRONMENTAL SCIENCE

**(As per NEP-2020 pattern)**



**(To be implemented from June-2025)**

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

## Faculty: Science and Technology

## Program: Bachelor of Science (B.Sc.) Part-II

## Sem-III and IV

## Environmental Science

## Program Preamble

Education serves the vital purpose of nurturing a holistic development of an individual's personality, and the educational system plays a pivotal role in facilitating this process. It equips learners with a comprehensive array of knowledge and skills essential for their personal growth and societal contribution. Within this framework, Environmental Science emerges as a cornerstone discipline, encompassing the dynamic interplay between the Earth's systems and its inhabitants, including life forms, and the atmosphere. This field also delves into the Earth's interior dynamics and its immediate spatial surroundings.

The contemporary curriculum is structured to cover foundational aspects of environmental studies, Earth's dynamic processes, climate dynamics, ecology, ecosystems, biodiversity, pollution management, environmental education, fossil records, biogeochemical cycles, energy-environment nexus, Sustainable Development Goals (SDGs), Environmental, Social, and Governance (ESG) principles, current environmental challenges, environmental chemistry, statistical methodologies, global environmental trends, environmental geology, hazards and disaster mitigation, and applications of remote sensing and Geographic Information Systems (GIS) in environmental analysis.

By engaging with the syllabus, students gain a profound understanding of Earth sciences, including seismic activities like earthquakes and volcanic eruptions, and grasp the nature and repercussions of various natural stressors acting on and beneath the Earth's surface.

Moreover, the study of environmental science equips students with applied knowledge drawn from disciplines such as chemistry, biology, geology, geography, climatology, physics, statistics, microbiology, and biotechnology. This interdisciplinary approach fosters a multifaceted understanding of environmental issues and solutions.

The syllabus for Environmental Science is meticulously designed to ensure the holistic development of students' personalities. It provides avenues for exposure to Discipline-Specific Courses, Generic Elective Courses, Value Enhancement Courses, and Skill Enhancement Courses. Through hands-on practical sessions and innovative instructional methods, students acquire specialized skills that are pertinent to their academic and professional pursuits, thus preparing them to tackle real-environment challenges effectively. The course contents are prepared as per UGC Model Curriculum under the Credit Framework guidelines of National Education Policy (NEP) 2020 and the guidelines given by Punyashlok Ahilyadevi Holkar Solapur University, Solapur for implementation of NEP.

**Program Objectives:**

- To develop conscience towards social responsibility about environment and sustainable development through curriculum and extra-curricular study.
- To develop scientific temperament with strong fundamental knowledge of the subject.
- To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies.
- To train students laboratory skills and hands on equipment trainings along with soft skills needed in solving environment issues and problems.

## ~ About National Education Policy (NEP) – 2020 ~

With the directions and guidelines issued by **Government of Maharashtra resolution dated 20th April 2023 and 16th May, 2023** regarding the implementation of NEP at UG and PG level, the Punyashlok Ahilyadevi Holkar Solapur University, Solapur has taken decision to implement NEP 2020 with Choice Based Credit System (CBCS) at Undergraduate level and Post Graduate level. This has been done to achieve the goals and objectives set in NEP-2020 such as- worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate and post-graduate degree.

The CBCS provides an opportunity for the students to select from the prescribed courses comprising core, elective/minor or skill based. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing performance of candidates.

**1. OUTLINE OF NEP:** The structure of the Three/Four-year bachelor's degree programme allows the opportunity to the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning in different institutions. The structure allows students to learn various components like:

**(a) Major (Core) Subject (DSC):** Comprises of Mandatory & Elective Courses for students to achieve:

- Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses are offered in all four years;
- 2 credit courses on Major Specific IKS shall be included under Major;
- Elective courses of Major will be offered in the third and/or final year;
- Vocational Skill Courses, Internship/Apprenticeship, Field Projects, Research Projects

**(b) Minor Subject (**18-20 Credits)

- The Minor subjects may be from the different disciplines of the same faculty of DSC Major (Core) or they can be from different faculty altogether;
- The credits of Minor subjects shall be completed in the first three years of UG Programme

**(c) Generic/ Open Elective Courses (OE) (**10-12 credits)

- GE/OE are to be offered in I and/or II year;
- Faculty-wise baskets of OE shall be prepared.
- OE/GE is to be chosen compulsorily from faculty other than that of the Major or as per the directions issued by NEP-Steering Committee

**(d) Vocational and Skill Enhancement Courses (VSEC)**

**i) Vocational Skill Courses (VSC): (**8-10 credits): Includes Hands on Training corresponding to the Major and/or Minor Subjects:

- To be offered in first three years;
- Wherever applicable vocational courses include skills based on advanced laboratory practical's

**ii) Skill Enhancement Courses (SEC): (**06 credits)

- To be offered in I and II year;
- To be selected from the basket of Skill Courses approved

**(e) Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC):** (14 Credits)

**i) AEC:** (08 credits): To be offered in I and II year

- English: 04 Credits and Modern Indian Language: 04 credits
- To be offered from the Basket approved. The focus for both languages should be on linguistic and communication skills.

**ii) IKS:** (2 Credits): To be offered in I Year

- Courses on IKS to be selected from the basket of IKS courses approved

**iii) VEC:** 04 Credits:To be offered in I year

- Value Education Courses (VEC) such as Understanding India, Environmental Science/Education, and Digital and Technological Solutions.

**(f) Field Projects/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research Project**

- Internship/Apprenticeship corresponding to the Major (Core) Subject: (8 Credits)
- Field Projects/Community Engagement and Service (CEP) corresponding to the Major (Core) Subject (minimum 4-6 credits)

To be offered in II and III years of UG Degree Programmes.

- Co-curricular Courses (CC 8-credits) such as Health and Wellness, Yoga education, sports and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts: offered in I and/or II year
- Research Projects: (12 credits)
  -To be offered in the final year for 4-year Honor's with Research UG Degree

**CREDIT:**

- Credit is a numerical value that indicates students work load (Contact Hours, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. The contact hours are transformed into credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured.
- **Theory: '**15 contact hours' for theory course constitute 'one credit'
- **Practical/Tutorial: '**30 contact hours' for practical course constitute 'one credit'.
- **Workshop based activities/Skill based activities:** Minimum 30 contact hours per credit in a semester is required
- **Internship/On-Job Training: '**30 contact hours' per credit in a semester is required (1 credit/week)
- **Community Engagement and Service-CEP/Field Project:** 30 contact hours per credit in a semester is required
- **Credit Framework under Three/Four Years UG Programme with Multiple Entry and Multiple Exit Options:**

The minimum and maximum credit structure for different levels under three- or four-year UG Programme with multiple entry and multiple exit options are as given below:

| Levels | Code | Qualification Titles | Credit Requirements | | Semester | Year |
|---|---|---|---|---|---|---|
| | | | Minimum | Maximum | | |
| 4.5 | 100-199 | UG Certificate | 40 | 44 | 2 | 1 |
| 5.0 | 200-299 | UG Diploma | 80 | 88 | 4 | 2 |
| 5.5 | 300-399 | Three Year Bachelor's Degree | 120 | 132 | 6 | 3 |
| 6.0 | 400-499 | Bachelor's Degree Honours OR Bachelor's Degree-Honours with Research | 160 | 176 | 8 | 4 |
| | 500-599 | First Year PG & or PG Diploma | 40 | 44 | 2 | 1 |

**2. CHOICE BASED CREDIT SYSTEM (CBCS):**

Each course carries a defined number of credits. The credits are based on the course structure, including the teaching mode and the number of contact hours for lecture, tutorial, and practical classes. One hour of theory/tutorial teaching per week equals one credit, and two hours of laboratory/demonstration classes per week equals one credit. Credits are considered based on the number of contact hours, course content, teaching methodology, allotted maximum marks.

The proportion of marks earned in a course and the credits given to that course will be used to calculate the Semester Grade Point Average (SGPA) or Cumulative Grade Point Average (CGPA). General Education credit refers to a unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching [lecture or

tutorial] or two hours of practical work/field work per week. Accordingly, one Credit would mean equivalent to 15 hrs' of theory or 30 hrs' of workshop/ lab/Internship/OJT/FP/CEP/CC work per semester.

| Sr. No. | One Credit | Number of Contact Hours |
|---|---|---|
| 1 | Theory | 15 Contact Hours |
| 2 | Practical | 30 Contact Hours |

**3. DEFINITIONS OF KEYWORDS:**

a) **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.

b) **Choice Based Credit System (CBCS):** The CBCS will provides options for students to select courses from the prescribed courses (core, open elective, discipline elective, ability and skill enhancement language, soft skill courses and so on).

c) **Course**: Usually referred to as 'papers' is a component of a programme. All courses need not carry the same weight. The courses will define learning objectives and learning outcomes. A course will be designed to comprise Contact Hours / tutorials / laboratory work / field work / project work / vocational training / viva / seminars / term papers / assignments/ presentations / self-study or a combination of some of these.

d) **Credit-Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree /diploma /certificate is prescribed in terms of the number of credits to be earned.

e) **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week in a semester. One credit is equivalent to one hour of lecture or tutorial or two hours of practical work/field work per week in a semester. It will generally be equal to 15 hours of instructions.

f) **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.

g) **Credit Point**: It is the product of grade points and the number of credits for a course.

h) **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, D and F.

i) **Programme**: A programme leading to the award of a degree, diploma, or Certificate.

j) **Semester**: Each semester will consist of over 15 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be generally scheduled from June to November and even semester from January to May.

k) **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is the ratio of total credit points secured by a student in various courses registered in a semester and the full course credits taken during that semester.

l) **Cumulative Grade Point Average (CGPA)**: It measures the overall cumulative performance of a student over all the semesters of a programme. The CGPA is the ratio of total credit points secured by a student in various courses in all the semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

m) **Transcript or Grade Card or Certificate:** Based on the grades earned, a graded certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured).

**Program Structure**

Duration: Four Years (Eight Semesters): As the University follows semester system, an academic year shall consist of two semesters. Program is designed to provide flexibility and multiple exit options to accommodate students' varying academic and career goals. The program structure is as follows:

1. Undergraduate Certificate **in Environmental Science**: Students who exit after the first year (two semesters) will receive a UG Certificate based on completed credits.
2. Undergraduate Diploma **in Environmental Science**: Students who decide to withdraw after the second year (four semesters) will receive a UG Diploma, provided they have completed the required credits.
3. Three-Year Undergraduate Degree i.e. B.Sc **in Environmental Science** : Students may leave the program after completing the third year (six semesters) to receive a three-year undergraduate degree.
4. B.Sc. Degree with Honours- The fourth year offers an advanced curriculum with a focus on research, allowing students to graduate with an **Honors Degree in Environmental Science**.

Re-entry Option: Students who leave the program with a UG Certificate or UG Diploma are allowed to re-enter within three years to complete the degree program.

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

## Faculty: Science and Technology

## Program: Bachelor of Science (B.Sc.) Part-II

## Sem-III and IV

## Environmental Science

## Program Outcomes (POs)

Students graduating from the Bachelor of Science in Environmental Science program will be able to:

**Major Courses**

- **PO1**: Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in the chosen major discipline.
- **PO2**: Apply disciplinary knowledge to solve complex problems, analyze data, and make informed decisions in professional and research contexts.

**Minor Courses:**

- **PO3**: Acquire complementary knowledge and skills from a related or distinct discipline, enhancing interdisciplinary understanding and versatility.

**Open Electives/General Electives:**

- **PO4**: Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

**Vocational and Skill Enhancement Courses:**

- **PO5**: Gain hands-on experience and technical proficiency in specific vocational areas, preparing for immediate career opportunities.

**Ability Enhancement Courses (AEC), Indian Knowledge System (IKS), and Value Education Courses (VEC):**

- **PO6**: Understand and appreciate the rich heritage of the Indian Knowledge System, integrating traditional wisdom with modern education.
- **PO7**: Develop ability enhancement skills like communication and life skills along with ethical values, social responsibility, and a strong sense of citizenship, contributing positively to society.

**Field Projects/Internship/Apprenticeship/Community Engagement Projects/ On Job Training/ Internship/Apprenticeship:**

- **PO8**: Apply theoretical knowledge to real-world situations through field projects, internships, community engagement and On job Training for gaining practical experience and problem-solving skills.

**Research Project/ Community Engagement Programme**:

- **PO9:** Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent projects handling capabilities

.

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

## Faculty: Science and Technology

## Program: Bachelor of Science (B.Sc.) Part-II

## Sem-III and IV

## Environmental Science

## Program Specific Outcomes (PSOs)

After completing degree program, the student will have ability for

- **PSO1: Comprehensive Understanding of Environmental Systems:** Graduates will possess a thorough comprehension of the Earth's environmental systems, including the interactions between the atmosphere, hydrosphere, lithosphere, and biosphere.
- **PSO2: Proficiency in Environmental Analysis:** Students will develop skills in analyzing environmental data, conducting fieldwork, and employing laboratory techniques to assess environmental quality and identify potential hazards.
- **PSO3: Sustainable Resource Management:** Graduates will be equipped with the knowledge and tools to develop sustainable strategies for managing natural resources, minimizing environmental degradation, and promoting conservation efforts.
- **PSO4: Problem-Solving Skills:** Through coursework and practical experience, students will enhance their critical thinking and problem-solving abilities, enabling them to address complex environmental challenges effectively.
- **PSO5: Awareness of Environmental Policies and Regulations:** Students will gain an understanding of environmental laws, regulations, and policies at local, national, and international levels, preparing them for careers in compliance, advocacy, and policymaking.
- **PSO6: Effective Communication:** Graduates will be proficient in communicating scientific concepts and findings to diverse audiences, including policymakers, stakeholders, and the general public, facilitating informed decision-making and public engagement.
- **PSO7: Interdisciplinary Approach:** The interdisciplinary nature of environmental science education will enable graduates to integrate knowledge from various fields, such as biology, chemistry, geology, geography, and sociology, to address complex environmental issues comprehensively.
- **PSO8: Research and Innovation:** Students will have the opportunity to engage in research projects, exploring cutting-edge topics in environmental science and contributing to the advancement of knowledge in the field.
- **PSO9: Career Opportunities:** Completion of a B. Sc in Environmental Science opens up a wide range of career opportunities in sectors such as environmental consulting, resource management, conservation organizations, government agencies, non-profit organizations, academia, and private industry.
- **PSO10: Global Citizenship:** Graduates will emerge as environmentally conscious global citizens, equipped with the skills, knowledge, and values necessary to contribute positively to environmental sustainability and address pressing environmental challenges facing society.

## Punyashlok Ahilyadevi Holkar Solapur University, Solapur

### Faculty of Science and Technology

### Structure for B.Sc. Part- II: Environmental Science (As per NEP-2020)

### Two Majors in Second Year structure

| Level/ Difficulty | Sem. | Faculty | | | Generic/ Open Elective GE/ OE | Vocational and Skill Enhancement Courses (SEC/VSC) | Ability Enhancement Course(AEC), IKS, VEC | Field Project/ RP/CC/Internship/Apprenticeship/ Community Engagement & Services | Credits | Cumulative Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Major | | Minor | | | | | | |
| | | DSC | DSE | | | | | | | |
| 5.0<br>200 | III | DSC1-3<br>Environmental Science (2+1) | -- | DSC2-3<br>Other Subject (2+1) | GE-3/OE-3 (2)<br>Environmental Science | VSC1 (2)<br>Practical based on DSC1 Major | L2-1 (2) | CC2 (2) | 22 | 44<br>UG Diploma (88) |
| | | DSC1-4<br>Environmental Science (2+1) | -- | DSC2-4<br>Other Subject (2+1) | | VSC2 (2)<br>Practical based on DSC2 Minor | | | | |
| | IV | DSC1-5<br>Environmental Science (2+1) | -- | DSC2-5<br>Other Subject (2+1) | GE-4/OE-4 (2)<br>Environmental Science | VSC3 (2)<br>Practical based on DSC1 Major | L2-2 (2) | FP1/CEP1 (2) | 22 | |
| | | DSC1-6<br>Environmental Science (2+1) | -- | DSC2-6<br>Other Subject (2+1) | | VSC4 (2)<br>Practical based on DSC2 Minor | | | | |
| Exit option: Award of UG Diploma in Major with 88 credits and an additional 4 credit score NSQF course /Internship OR Continue with Major | | | | | | | | | | |

| PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR<br>B.Sc. II: Environmental Science (As per NEP 2020) | | | | | | |
|---|---|---|---|---|---|---|
| **Semester– III** | | | | | | |
| **Coarse Type** | **Coarse Vertical** | **Title of Course (Paper)** | **Distribution of Marks** | | | **Total Credits** |
| | | | **IA** | **UA** | **Total** | |
| Major | DSC1-3 | Fundamentals of Environmental Biology | 20 | 30 | 50 | 2 |
| Major Practical | PRDSC1-3 | Practical based on DSC1-3 | 10 | 15 | 25 | 1 |
| Major | DSC1-4 | Ecology and Environment | 20 | 30 | 50 | 2 |
| Major Practical | PRDSC1-4 | Practical based on DSC1-4 | 10 | 15 | 25 | 1 |
| Minor | DSC2-3 | To be selected Other than Environmental Science | 20 | 30 | 50 | 2 |
| Minor Practical | PRDSC2-3 | Practical based on DSC2-3 | 10 | 15 | 25 | 1 |
| Minor | DSC2-4 | To be selected Other than Environmental Science | 20 | 30 | 50 | 2 |
| Minor Practical | PRDSC2-4 | Practical based on DSC2-4 | 10 | 15 | 25 | 1 |
| GE/OE | GE-3/OE-3 | Life and Its Environment | 20 | 30 | 50 | 2 |
| VSC | PRVSC1 | Practical Based on DSC1 Major | 20 | 30 | 50 | 2 |
| VSC | PRVSC2 | Practical Based on DSC2 Minor | 20 | 30 | 50 | 2 |
| AEC | L2-1 | AEC | 20 | 30 | 50 | 2 |
| CC | CC2 | CC | 20 | 30 | 50 | 2 |
| **Total Marks +Credit for Semester–III** | | | **220** | **330** | **550** | **22** |
| **Semester-IV** | | | | | | |
| Major | DSC1-5 | Environmental Pollution | 20 | 30 | 50 | 2 |
| Major Practical | PRDSC1-5 | Practical based on DSC1-5 | 10 | 15 | 25 | 1 |
| Major | DSC1-6 | Climatology and Meteorology | 20 | 30 | 50 | 2 |
| Major Practical | PRDSC1-6 | Practical based on DSC1-6 | 10 | 15 | 25 | 1 |
| Minor | DSC2-5 | To be selected Other than Environmental Science | 20 | 30 | 50 | 2 |
| Minor Practical | PRDSC2-5 | Practical based on DSC2-5 | 10 | 15 | 25 | 1 |
| Minor | DSC2-6 | To be selected Other than Environmental Science | 20 | 30 | 50 | 2 |
| Minor Practical | PRDSC2-6 | Practical based on DSC2-6 | 10 | 15 | 25 | 1 |
| GE/OE | GE-4/OE-4 | Wildlife Conservation and Management | 20 | 30 | 50 | 2 |
| VSC | PRVSC3 | Practical Based on DSC1 Major | 20 | 30 | 50 | 2 |
| VSC | PRVSC4 | Practical Based on DSC2 Minor | 20 | 30 | 50 | 2 |
| AEC | L2-2 | AEC | 20 | 30 | 50 | 2 |
| FP/CEP | FP1 / CEP1 | Field Projects/ Community Engagement Projects | 20 | 30 | 50 | 2 |
| **Total Marks + Credit for Semester-IV** | | | **220** | **330** | **550** | **22** |

**Abbreviations:**

| | |
|---|---|
| **GE/OE:** Generic/ Open Electives | **CC:** Co-curricular Courses |
| **VSEC:** Vocational Skill and Skill Enhancement Courses | **FP:** Field Projects |
| **AEC:** Ability Enhancement Courses | **CEP:** Community Engagement Projects |

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Major (DSC1-3) Paper-III**<br>**Course Code:**<br>**Course Name:** Fundamentals of Environmental Biology |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

- To introduce the fundamental concepts of biology and its relevance to environmental science.
- To understand biological classification, taxonomy, and species concepts.
- To explore the origin and evolution of life, along with evolutionary mechanisms and biogeographical patterns.
- To study ecological adaptations in plants and animals in response to environmental conditions.
- To examine biodiversity, bioresources, and their significance for sustainability.
- To analyze the causes and consequences of mass extinctions and their impact on biodiversity.

**Course Outcomes (COs):** At the end of this course,

- CO1: Demonstrate an understanding of fundamental biological principles, classification systems, evolutionary processes, and species distribution in an environmental context.
- CO2: Analyze ecological adaptations, bioresources, and the impact of mass extinctions while proposing sustainable conservation strategies.

| **Unit 1: Fundamentals of Biology and Evolutionary Perspectives** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Introduction to Biology**: Definition, Branches, Scope, and Importance from an Environmental Perspective.
- **Biological Classification and Taxonomy**:
  - Taxonomic Principles – Aim, Objectives, Hierarchy, Kingdoms.
  - History of Classification: Linnaeus System, Bentham & Hooker System.
  - Components of Systematics – Characterization, Classification, Identification & Nomenclature.
  - Concept of Species: Morphological, Biological, Phylogenetic, Ecological Perspectives.
- **Evolution and Origin of Life**:
  - Theories of Origin of Life.
  - Evolution of Life through Geological Time (Eras, Periods, Epochs).
  - Charles Darwin's Voyage of HMS Beagle and 'Survival of the Fittest' Theory.
  - Evolutionary Events and Present-Day Distribution of Life on Earth.
- **Factors Influencing Evolution and Biogeography**:
  - Geological (Continental Drift, Barriers, and Bridges).
  - Climatic (Barriers and Bridges).
  - Evolutionary (Speciation, Natural Selection, Adaptive Radiation).
  - Biogeographical Zones of the World – Physical, Microbial, Floral, and Faunal Characteristics.

| **Unit 2: Ecological Adaptations, Bioresources, and Extinction Events** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Ecological Adaptations in Plants and Animals**:
  - Plants: Hydrophytes, Mesophytes, Epiphytes, Xerophytes, and Halophytes.
  - Animals: Mimicry, Vestigiality, and Adaptations to Environmental Conditions.

- **Biological Diversity of India**:
  - Major Genera, Species, and Sub-Species of Flora and Fauna.
  - Major Ecological Types of India.
- **Bioresources and Their Significance**:
  - Forests – Major Types (Global & India).
  - Agricultural Crops – Major Food Plants (Global & India).
  - Livestock – Major Varieties (Global & India).
  - Fisheries Resources – Saline & Freshwater.
  - Extraction of Bioresources – Traditional & Modern Methods.
  - Threats to Local Bioresources – Overexploitation, Habitat Loss, Invasive Species.
- **Mass Extinctions and Their Impact**:
  - Paleontological Evidences of Mass Extinctions and Explosions.
  - The Current Mass Extinction – Rate, Causes, and Possible Remedies.

**Text Books / Reference Books:**


1. An Advanced textbook on Biodiversity – Principles & Practice, K. V. Krishnamurthy, Oxford & IBH Publishing Co. Pvt. Ltd., Special Indian Edtn
2. A Textbook of Plant Ecology' Ambashta R.S. & Ambashta N.K (1999) CBS Publ. & Distributers, New Delhi
3. Ecology: Principles and Applications' Chapman J.L. & Reiss M.J. (1995) Cambridge University Press
4. Environmental Science: A Global Concern' Cunningham W.P. & Saigo S.W. (1997) WCB, McGraw Hill
5. 'Elements of Ecology' Sharma P.D. Rastogi Publication
6. 'Environmental Science' Tyler M.G. Jr. (1997) Wadsworth Publ. Co.
7. 'Environmental Studies' Benny Joseph (2005) Tata McGraw Hill Publ. Co. Ltd.
8. 'Patterns in the Living World' – Biology-an Environmental approach, John Murray, London
9. Biological science, D. J. Taylor, N.P.O. Green & G.W Stout, Cambridge Low Price Edition, 3rd Edtn.


**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-III: Environmental Science**

**Vertical: Major (DSC1-3) Laboratory Practical-III**

**Course Code:**

**Course Name: Practical:** Fundamentals of Environmental Biology

| | |
|---|---|
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

- To develop practical fieldwork skills for documenting local flora and fauna, including identification techniques and biodiversity assessment methods.
- To enhance understanding of plant and animal adaptations to diverse environmental conditions, focusing on their evolutionary mechanisms and ecological significance.
- To strengthen taxonomic proficiency in species identification, classification, and the use of taxonomic keys for biodiversity research and conservation.
- To provide insights into biogeographical concepts, including species distribution patterns, continental drift, and speciation, highlighting the interplay of geological, climatic, and evolutionary factors in shaping biodiversity.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Demonstrate proficiency in biodiversity assessment, species identification, and ecological interpretation through fieldwork and taxonomic classification.
- CO2: Apply knowledge of plant and animal adaptations, biogeographical processes, and resource management to support conservation and sustainable decision-making.

| **Fundamentals of Environmental Biology** | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|
| 1. Introduction to Laboratory safety rules and introduction to laboratory equipment | | |
| 2. Identify and document local flora and fauna, focusing on major genera and species. (Field Practical) | | |
| 3. Study of Plant Adaptations under various environmental conditions (Hydrophytes, Mesophytes, Epiphytes, Halophytes & Xerophytes). | | |
| 4. Study of Animal Adaptations under various environmental conditions (Structural: Camouflage, mimicry, Vestigiliaty. Behavioural: Hibernation, Migration, | | |
| 5. Identifying native plants for plantation with respect to Geography and Climate | | |
| 6. Conduct/demonstrate a laboratory experiment to simulate the conditions of early Earth and discuss the origin of life | | |
| 7. Use maps and models to understand the concept of continental drift and its impact on the distribution of life. | | |
| 8. Investigation of how climatic barriers and bridges affect species distribution (e.g., temperature, precipitation). | | |
| 9. Practical on the use of taxonomic keys to classify plant and animal specimens. | | |
| 10. Field visits to study and document different forest types in the local area, local markets to study and document saline and freshwater fishery resources. | | |
| 11. Practical identification and study of major food plants used in agriculture. | | |

**Text Books / Reference Books:**


1. Meetu Gupta , Fundamentals of Environmental Biology 2018
2. Dr. P S Verma & Dr. V K Agarwal Environmental Biology (Principles of Ecology) S Chand Publishing 1983
3. Dr. P S Verma. A Manual of Practical Zoology: Invertebrates. S Chand Publishing
4. B.P.Pandey. Modern Practical Botany Vol-I S Chand Publishing
5. Umavathi Subramaniam. Practical Manual on Environmental Biology and Evolution LAP Lambert Academic Publishing
6. Trivedi, P. K., & Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.
7. Trivedi, R. K., & others. (1987). Practical Methods in Ecology and Environmental Science. Publisher.
8. American Public Health Association (APHA), Water Environment Federation (WEF), & American Water Works Association (AWWA). (2017). Standard Methods for the Examination of Water and Wastewater. APHA– WEF.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Major (DSC1-4) Paper-IV**<br>**Course Code:**<br>**Course Name:** Ecology and Environment |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. **Understand Ecosystem Structure and Function** – Explore the components of ecosystems, energy flow, trophic interactions, and ecological productivity.
2. **Analyze Major Ecosystems and Their Characteristics** – Study terrestrial and aquatic ecosystems, including their structure, function, and ecological significance.
3. **Examine Biogeochemical Cycles and Environmental Sustainability** – Understand the cycling of essential elements and their role in maintaining ecological balance.
4. **Explore Ecological Succession and Adaptations** – Learn about natural and human-influenced succession, abiotic influences, and adaptation mechanisms in organisms.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Demonstrate an understanding of ecosystem structure, function, and energy flow by analysing abiotic and biotic components, trophic interactions, and ecological productivity.
- CO2: Explain ecological processes, biogeochemical cycles, and population dynamics to assess environmental sustainability, species interactions, and the impact of ecological changes.

| **Unit 1: Fundamentals of Ecology and Ecosystem Dynamics** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|
| • **Introduction to Ecology:** Definition, types of ecosystems.<br>• **Ecosystem Structure and Function:** Abiotic and biotic components, energy flow, laws of thermodynamics in ecology.<br>• **Trophic Interactions:** Food chains (grazing, parasitic, detritus), food webs, ecological pyramids (number, biomass, energy).<br>• **Productivity and Bioaccumulation:** Primary, secondary, and net productivity, bioaccumulation, and biomagnification.<br>• **Major Ecosystems:** Characteristics of terrestrial (forest, mangrove, grassland, arid land, wetland) and aquatic ecosystems (ponds, rivers, estuaries, marine), cropland ecosystems.<br>• **Abiotic Factors and Adaptations:** Organismal response to abiotic factors, essential elements, limiting factors (Liebig's Law, Shelford's Law), temperature tolerance, thermal adaptations, and effects of light on plants and animals. | | |
| **Unit 2: Ecological Processes, Biogeochemical Cycles, and Population Ecology** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
| • **Ecological Succession:** Primary and secondary succession, natural and human-influenced succession, hydrarch and xerarch succession, ecotone, edge effect, ecotypes, and ecological indicators.<br>• **Ecological Niche:** Concept and types of niches.<br>• **Biogeochemical Cycles:** Water cycle, gaseous cycles (carbon, nitrogen, oxygen), sedimentary cycles (sulfur, phosphorus).<br>• **Population Ecology:** Population characteristics (density, natality, mortality, life table, age distribution, age pyramids, sex ratio, biotic potential, environmental resistance).<br>• **Population Dynamics:** Growth rate, dispersion (emigration, immigration, migration), and population size regulation. | | |

**Text Books / Reference Books:**


1. Odum, E. P. (1983). Basic Ecology.
2. P.D. Sharma. (1989) Basic Ecology
3. Trivedi, P. K., & Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.
4. Trivedi, R. K., & others. (1987). Practical Methods in Ecology and Environmental Science. Publisher.
5. Colinvaux, P. A. (1973). Introduction to Ecology. John Wiley.
6. Rolan, R. G. (1973). Laboratory and Field Investigations in General Ecology. Macmillan Co.
7. Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Publishing Co. Ltd.
8. Chapman, J. L., & Reiss, M. J. (2010). Ecology: Principles and Applications (2nd ed.). Cambridge University Press.
9. Donn, W. L. (1971). The Earth: Our Physical Environment. John Wiley & Sons.
10. Turk, J., & Turk, A. (1984). Environmental Science. Saunders.
11. Eugen, E. D. (1983). Environmental Science. W.C. Brown Co
12. Dash, M. C. – Fundamentals of Ecology, Tata McGraw-Hill.
13. Miller, G. T., & Spoolman, S. – Living in the Environment, Cengage Learning.
14. Kormondy, E. J. – Concepts of Ecology, Prentice Hall of India.
15. Ricklefs, R. E. – Ecology, W. H. Freeman & Company.
16. Mann, K. H., & Lazier, J. R. N. – Dynamics of Marine Ecosystems, Blackwell Publishing.


| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Major (DSC1-4) Laboratory Practical-IV**<br>**Course Code:**<br>**Course Name: Practical:** Ecology and Environment |
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

1. Understand Ecosystem Components – Identify and analyze abiotic and biotic components in different ecosystems through field and laboratory studies.
2. Analyze Energy Flow and Productivity – Measure primary productivity and construct ecological pyramids to understand trophic interactions.
3. Study Ecological Processes – Observe ecological succession, population dynamics, and biogeochemical cycles through experiments and fieldwork.
4. Assess Environmental Factors – Evaluate soil and water quality parameters, including pH, dissolved oxygen, and organic matter content.
5. Examine Human Impact on Ecosystems – Demonstrate bioaccumulation, biomagnification, and the role of ecological indicators in environmental assessment.

**Course Outcomes (COs):** At the end of this course:

- CO1: **Apply Ecological Concepts in Field and Laboratory Studies** – Demonstrate the ability to analyze ecosystem components, energy flow, and population dynamics through hands-on experiments and field observations.
- CO2: **Evaluate Environmental Parameters and Ecological Processes** – Assess abiotic and biotic factors, biogeochemical cycles, and human-induced environmental changes to understand ecosystem functioning and sustainability.

| Ecology and Environment | No. of Practical Hrs: 60 | Weightage: 25 Marks |
|---|---|---|

1. **Study of Ecosystem Components** – Identification of abiotic and biotic components in different ecosystems (terrestrial and aquatic).
2. **Energy Flow and Productivity Estimation** – Measurement of primary productivity in an aquatic/terrestrial ecosystem using the light and dark bottle method.
3. **Trophic Interactions and Food Web Analysis** – Construction of food chains and food webs using local ecosystem data.
4. **Ecological Pyramids** – Preparation and interpretation of pyramids of number, biomass, and energy.
5. **Bioaccumulation and Biomagnification** – Demonstration of pollutant accumulation in the food chain using a simulation experiment.
6. **Study of Major Ecosystems** – Field visit and documentation of different ecosystem characteristics (forest, wetland, grassland, cropland).
7. **Measurement of Abiotic Factors** – Analysis of temperature, pH, dissolved oxygen, and light penetration in aquatic and terrestrial environments.
8. **Ecological Succession Study** – Observation and analysis of plant succession in a given area (hydrarch and xerarch succession).
9. **Soil Analysis** – Determination of soil pH, moisture content, texture, and organic matter.
10. **Population Ecology Studies** – Estimation of population density using the quadrat or line transect method.
11. **Biogeochemical Cycles** – Demonstration of carbon dioxide exchange in the environment through respiration experiments.
12. **Study of Population Growth** – Observation of population growth patterns in a controlled microbial culture.
13. **Field Study on Environmental Indicators** – Identification of ecological indicators and their significance in environmental assessment.
14. **Effect of Light and Temperature on Plants** – Investigation of the impact of light intensity and temperature variations on plant growth.

**Text Books / Reference Books:**


1. Trivedi, P. K., & Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.
2. Trivedi, R. K., & others. (1987). Practical Methods in Ecology and Environmental Science. Publisher.
3. American Public Health Association (APHA), Water Environment Federation (WEF), & American Water Works Association (AWWA). (2017). Standard Methods for the Examination of Water and Wastewater. APHA– WEF.
4. Odum, E. P., & Barrett, G. W. – Fundamentals of Ecology (5th Edition), Brooks/Cole.
5. Smith, T. M., & Smith, R. L. – Elements of Ecology (9th Edition), Pearson.
6. Chapin, F.S., Matson, P.A., & Vitousek, P.–Principles of Terrestrial Ecosystem Ecology, Springer.
7. Begon, M., Townsend, C. R., & Harper, J. L. – Ecology: From Individuals to Ecosystems (4th Edition), Wiley-Blackwell.
8. Molles, M. C. – Ecology: Concepts and Applications (8th Edition), McGraw-Hill.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Generic Elective/Open Elective Paper-III (GE-3/OE-3)**<br>**Course Code:**<br>**Course Name:** Life and Its Environment |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the origin and evolution of life, including major theories and the role of microbes in early life forms.
2. To explore the classification of living organisms, including microbial diversity and their ecological and industrial significance.
3. To study the structure and function of cells, including cellular components, energy production, and metabolic pathways.
4. To analyze the diversity, growth, and adaptations of plants and animals, along with their evolutionary trends and environmental interactions.

**Course Outcomes (COs):** At the end of this course,: the students will gain

- CO1: Students will be able to explain the fundamental principles of microbial diversity, evolution, and classification, and their significance in biological systems.
- CO2: Students will develop an understanding of cell structure, energy metabolism, and biological kingdoms, enabling them to relate these concepts to real-world biological applications.

| **Unit 1: Microbial Origins, Evolution, and Classification** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Origin of Life:** History of Earth, theories of the origin of life, Miller's experiment, nature of the earliest organisms, and spontaneous generation.
- **Evolutionary Biology:** Natural selection, species evolution, phylogenetic relationships, and the quest for extraterrestrial life.
- **Biological Classification:** Whittaker's five-kingdom classification and its significance.
- **Microbial Diversity:**
  - **Bacteria:** General characteristics, diversity, and beneficial and harmful activities.
  - **Eukaryotic Microbes:** Broad classification and significance of fungi, algae, and protozoa.
  - **Viruses:** General characteristics, structure, and replication mechanisms.

| **Unit 2: Cellular Structure, Energy Systems, and Biological Kingdoms** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Cell Structure and Function:**
  - Cell differentiation and levels of organization.
  - Structure and function of the cell wall, membrane, appendages, organelles, and cytoplasmic content.
  - Nutrient uptake across membranes.
- **Energy Systems:**
  - Energy and carbon sources, ATP generation, and reducing power.
  - Electron transport chain in respiration and photosynthesis.
- **Cell Processes:**
  - Enzymes: Properties, mechanism of catalysis, and factors affecting enzyme action.
  - Cell division: Mitosis and meiosis, generation time, and growth rate.
- **Plant Kingdom:**
  - Plant body structure: Organ systems, tissues, stem, root, and leaves.

- Growth: Nutritional requirements, phytohormones, reproductive structures, pollination, fertilization, and asexual reproduction.
- Classification: Bryophytes, vascular plants, gymnosperms, and angiosperms.

- **Animal Kingdom:**
  - General characteristics, body organization (systems, organs, tissues, coordination, and energy requirements).
  - Primitive and advanced marine animals, adaptation to land, environmental interactions.
  - Evolution in vertebrates (fish, amphibians, reptiles, mammals) and the extinction of dinosaurs.

**Textbooks and Reference Books:**


1. Elden D Enger, FC Ross and DB Bailey (2011) Concepts in Biology, (14th Ed), TMH
2. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (2017) Campbell Biology (11th Ed), Pearson
3. Mary A Clark, Matthew Douglas, and Jung Choi (2018) Biology (2nd Ed) OpenStax, Rice Univ, USA
4. Cowan K and KP Talaro (2009) Microbiology: A Systems Approach, (2nd Ed), McGraw-Hill
5. Purves William K, David Sadava, Gordon H. Orians, and H. Craig Heller (2006) Life: The Science of Biology, (7th Ed), Academic Internet


**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-III: Environmental Science**

**Vertical: Vocational Skill Course (VSC) Laboratory Practical-I**

**Course Code:**

**Course Name: Practical based on Major DSC1**

| | |
|---|---|
| ***Teaching Scheme: Credits:** 02 | ***Examination Scheme: Total Marks :** 50 |
| **Total Contact Hrs:** 60 | **UA:** 30 Marks |
| **Practical:** 04 Hours/Week | **IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To develop practical skills in microbial identification and classification through microscopy and staining techniques.
2. To understand evolutionary principles through experiments on phylogenetics, natural selection, and fossil analysis.
3. To explore cellular structures and biochemical processes, including enzyme activity, ATP generation, and electron transport chain demonstrations.
4. To study the structural and functional adaptations of plants and animals through tissue identification, pollination studies, and comparative anatomy.

**Course Outcomes (COs):** At the end of this course,: the students will gain

- CO1: Students will be able to perform basic microbiological techniques, analyze microbial diversity, and interpret evolutionary relationships.
- CO2: Students will gain hands-on experience in cell biology, plant and animal classification, and biochemical experiments, enhancing their understanding of biological processes.

| Practical based on Major DSC1 | No. of Practical Hrs: 60 | Weightage: 50 Marks |
|---|---|---|

1. **Study of Microbial Diversity** – Microscopic observation and identification of bacteria, fungi, algae, and protozoa.
2. **Study of Cell Structure** – Microscopic observation of plant and animal cells.
3. **Cell Wall and Membrane Study** – Osmosis and plasmolysis experiments in plant cells.
4. **Observation of Mitosis and Meiosis** – Temporary mounts of onion root tips and flower buds.
5. **Enzyme Activity Demonstration** – Effect of temperature and pH on enzyme action (e.g., catalase activity).
6. **ATP Generation Experiment** – Study of yeast fermentation and $CO_2$ production.
7. **Plant Tissue Identification** – Observation of different plant tissues (xylem, phloem, parenchyma, etc.).
8. **Study of Pollination and Fertilization** – Microscopic observation of pollen grains and stigma.
9. **Observation of Animal Body Structures** – Comparative study of external features of different animal groups.
10. **Adaptations in Animals** – Study of features of aquatic vs. terrestrial organisms.
11. **Study of Fossil Evidence** – Examination of fossil samples or models to understand evolution.

**Text Books / Reference Books:**


1. **Prescott's Microbiology** – Joanne Willey, Linda Sherwood, and Christopher Woolverton
2. **Microbiology: An Introduction** – Gerard J. Tortora, Berdell R. Funke, and Christine L. Case
3. **Brock Biology of Microorganisms** – Michael T. Madigan, John M. Martinko, and Kelly S. Bender
4. **Cell and Molecular Biology: Concepts and Experiments** – Gerald Karp
5. **Biology: A Global Approach** – Neil A. Campbell, Lisa A. Urry, and Michael L. Cain
6. **Principles of Biochemistry** – Lehninger, Nelson, and Cox
7. **Plant Physiology and Development** – Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy
8. **Animal Physiology** – Richard W. Hill, Gordon A. Wyse, and Margaret Anderson
9. **Evolution** – Douglas J. Futuyma and Mark Kirkpatrick
10. **Biochemistry** – Donald Voet and Judith G. Voet

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Major (DSC1-5) Paper-V**<br>**Course Code:**<br>**Course Name:** Environmental Pollution |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the sources, types, and effects of environmental pollutants in air, water, soil, and physical environments.
2. To analyze the dispersion and impact of pollutants on human health, ecosystems, and biodiversity.
3. To learn pollution control strategies, technologies, and regulatory standards for environmental protection.
4. To develop skills in monitoring, assessing, and mitigating environmental pollution through practical applications.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to identify and analyze various environmental pollutants and their effects on human health and ecosystems.
- CO2: Students will demonstrate knowledge of pollution control measures, monitoring techniques, and regulatory frameworks.

| **Unit 1: Fundamentals of Environmental Pollution and Control** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Air Pollution and Control**
   - Atmospheric composition and stratification.
   - Sources and classification of air pollutants (criteria and specific pollutants).
   - Effects of air pollution on plants, human health, materials, and ecosystems.
   - Air pollutant dispersion, plume behavior, temperature inversion, lapse rate, stability, and meteorological parameters.
   - Airborne diseases (infectious and non-infectious).
   - Air pollution control devices and strategies.
2. **Water Pollution and Control**
   - Sources and classification of water pollutants (organic, inorganic, heavy metals).
   - Water quality parameters (BOD, COD, DO, pH, bacteriological examination).
   - Dispersal of pollutants in aquatic ecosystems, eutrophication, bioaccumulation, and biomagnification.
   - Impact of water pollution on human health and aquatic life.
   - Waterborne diseases and thermal pollution in water.
   - Wastewater characteristics (domestic, industrial, and agricultural) and control measures.

| **Unit 2: Land, Physical, and Radiation Pollution and Control** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Soil Pollution and Control**
   - Soil composition, profile, and characteristics.
   - Sources of soil pollution: industrial effluents, fertilizers, pesticides, heavy metals, and waste disposal.
   - Effects of soil pollution on flora, fauna, and groundwater contamination.
   - Measures for controlling soil pollution.

2. **Physical Pollution and Control**
    - **Noise Pollution**: Sources, sound properties (pressure level, decibels, intensity, pitch, noise indices), monitoring methods, and permissible standards.
    - Effects of noise pollution on humans and animals.
    - **Thermal Pollution**: Sources and effects on human and animal health.
    - **Radiation Pollution**: Types, sources, health hazards, and control measures.
    - **Space Pollution**: Causes and environmental concerns.
    - Strategies for controlling physical pollution.

**Text Books / Reference Books:**


1. Environmental Pollution Control Engineering – C.S. Rao
2. Environmental Chemistry – A.K. De
3. Fundamentals of Air Pollution – Daniel Vallero
4. Environmental Science: A Global Concern – William P. Cunningham and Mary A. Cunningham
5. Water and Wastewater Technology – Mark J. Hammer
6. Soil Pollution and Its Control – P.K. Gupta
7. Noise Pollution and Control Strategy – S.P. Singal
8. Introduction to Environmental Engineering and Science – Gilbert M. Masters and Wendell P. Ela
9. Radiation and Environmental Biophysics – R.M. Eisberg
10. Industrial Pollution Control Handbook – Lund H.F.


**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-IV: Environmental Science**

**Vertical: Major (DSC1-5) Laboratory Practical-V**

**Course Code:**

**Course Name: Practical:** Environmental Pollution

| | |
|---|---|
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To develop hands-on skills in measuring and analyzing environmental pollution parameters for air, water, and soil.
2. To understand and apply scientific methods for assessing the impact of pollution on ecosystems and human health.
3. To gain proficiency in using environmental monitoring instruments and interpreting data for pollution control.
4. To conduct experiments that demonstrate key pollution-related phenomena such as eutrophication, thermal pollution, and radiation hazards.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to perform environmental pollution monitoring and analyze data for air, water, and soil quality assessment.
- CO2: Students will demonstrate practical knowledge of pollution indicators, bioindicators, and mitigation techniques for environmental protection.

| **Environmental Pollution** | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|

1. Measurement of air quality parameters (PM2.5, PM10, $SO_2$, $NO_2$) using an air sampler.
2. Analysis of meteorological parameters: wind rose, temperature inversion, and lapse rate.
3. Determination of dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) in water samples.
4. Study of waterborne and airborne diseases through case studies.

5. Identification of bioindicators of pollution in aquatic ecosystems.
6. Soil pollution assessment: pH, texture, organic matter, and heavy metal contamination.
7. Measurement of noise pollution levels using a sound level meter.
8. Demonstration of eutrophication effects in a controlled aquatic setup.
9. Study of thermal pollution effects on water temperature and dissolved oxygen.
10. Radiation monitoring using dosimeters and study of radiation hazards.

**Text Books / Reference Books:**


1. Environmental Monitoring and Characterization – J. Artiola, I.L. Pepper, and M.L. Brusseau
2. Standard Methods for the Examination of Water and Wastewater – APHA, AWWA, WEF
3. Environmental Pollution Analysis – S.M. Khopkar
4. Manual of Environmental Analysis – N.C. Aery
5. Practical Environmental Analysis – M. Reeve
6. Air Pollution: Measurement, Modelling, and Mitigation – S. Pal Arya
7. Soil and Water Pollution Monitoring, Protection and Remediation – I. Twardowska et al.
8. Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes – Pradyot Patnaik


**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-IV: Environmental Science**

**Vertical: Major (DSC1-6) Paper-VI**

**Course Code:**

**Course Name:** Climatology and Meteorology

| | |
|---|---|
| ***Teaching Scheme: Credits:** 02 | ***Examination Scheme: Total Marks :** 50 |
| **Total Contact Hrs:** 30 | **UA:** 30 Marks |
| **Lectures:** 02 Hours/Week | **IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

- To understand the fundamental principles of climatology and meteorology and their relevance to environmental science.
- To analyze atmospheric processes such as temperature regulation, wind patterns, and precipitation.
- To examine the causes and impacts of climate change and atmospheric disturbances.
- To develop skills in interpreting meteorological data and using climate information for environmental applications.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to explain key atmospheric processes and their role in weather and climate patterns.
- CO2: Students will acquire practical knowledge of meteorological instruments and their applications in environmental monitoring.

| **Unit 1: Fundamentals of Climatology and Meteorology** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- Introduction to Climatology and Meteorology: Scope, significance, and applications in environmental science.
- Composition and Structure of the Atmosphere: Troposphere, stratosphere, mesosphere, thermosphere, and exosphere.
- Solar Radiation and Heat Budget: Energy balance, albedo, greenhouse effect, and global heat distribution.
- Atmospheric Pressure and Wind Systems: General circulation of the atmosphere, monsoons, cyclones, and jet streams.
- Humidity, Precipitation, and Cloud Formation: Types of precipitation, factors influencing rainfall, and cloud classification.

| Unit 2: Weather, Climate, and Environmental Applications | Contact Hrs-15 | Weightage: ~23 Marks |
|---|---|---|

- Weather and Climate: Differences, classification of world climates (Köppen's classification), and climatic zones of India.
- Atmospheric Disturbances: El Niño, La Niña, tropical cyclones, and extreme weather events.
- Climate Change and Its Impacts: Causes, consequences, and adaptation strategies.
- Meteorological Instruments and Data Interpretation: Barometer, anemometer, hygrometer, rain gauge, and satellite-based weather monitoring.
- Applications in Environmental Science: Role of climatology in agriculture, hydrology, disaster management, and pollution studies.

**Text Books / Reference Books:**


1. The Atmosphere: An Introduction to Meteorology – Frederick K. Lutgens and Edward J. Tarbuck
2. Climatology: An Atmospheric Science – John E. Oliver and John J. Hidore
3. Essentials of Meteorology – C. Donald Ahrens
4. An Introduction to Climate – Glenn T. Trewartha and Lyle H. Horn
5. Meteorology Today: An Introduction to Weather, Climate, and the Environment – C. Donald Ahrens
6. Climatology – Robert V. Rohli and Anthony J. Vega
7. Environmental Meteorology – S. Pal Arya
8. Climate Change: A Very Short Introduction – Mark Maslin


**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-IV: Environmental Science**

**Vertical: Major (DSC1-6) Laboratory Practical-VI**

**Course Code:**

**Course Name: Practical:** Climatology and Meteorology

| | |
|---|---|
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

- To develop practical skills in measuring and analyzing atmospheric parameters such as solar radiation, pressure, wind patterns, and humidity.
- To understand the dynamics of weather phenomena, including monsoons, cyclones, El Niño, and La Niña, through case studies and data analysis.
- To apply meteorological instruments and techniques for weather monitoring and climate classification.
- To assess the impact of climate change and extreme weather events using observational and analytical methods.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to conduct meteorological measurements and interpret atmospheric data for environmental studies.
- CO2: Students will gain practical knowledge in climate classification, weather forecasting, and disaster management strategies.

| Climatology and Meteorology | No. of Practical Hrs: 60 | Weightage: 25 Marks |
|---|---|---|

1. **Study of Atmospheric Layers** – Understanding the structure of the atmosphere using models and charts.
2. **Measurement of Solar Radiation** – Use of pyranometer to measure solar energy and albedo effect.
3. **Demonstration of Greenhouse Effect** – Experimental setup to observe heat trapping by greenhouse gases.
4. **Measurement of Atmospheric Pressure** – Use of a barometer to record pressure variations.
5. **Study of Wind Patterns** – Observation of wind direction and speed using an anemometer.
6. **Humidity and Precipitation Measurement** – Use of a hygrometer and rain gauge for weather analysis.
7. **Cloud Identification and Classification** – Observing different types of clouds and their relation to weather conditions.
8. **Köppen's Climate Classification** – Identification of different climatic zones using maps.
9. **Study of Monsoons and Cyclones** – Analysis of case studies on monsoon patterns and cyclonic disturbances.
10. **El Niño and La Niña Effects** – Understanding oceanic-atmospheric interactions using data interpretation.
11. **Temperature and Humidity Variations** – Data collection and graphical representation of daily temperature and humidity.
12. **Meteorological Data Analysis** – Interpretation of weather station data, satellite images, and climate models.
13. **Impact of Climate Change on Local Environment** – Field survey or secondary data analysis on climate change effects.
14. **Disaster Management Case Study** – Analysis of extreme weather events and disaster mitigation strategies.

**Text Books / Reference Books:**


1. The Atmosphere: An Introduction to Meteorology – Frederick K. Lutgens and Edward J. Tarbuck
2. Essentials of Meteorology – C. Donald Ahrens
3. Climatology: An Atmospheric Science – John E. Oliver and John J. Hidore
4. Meteorology Today: An Introduction to Weather, Climate, and the Environment – C. Donald Ahrens
5. An Introduction to Climate – Glenn T. Trewartha and Lyle H. Horn
6. Climate Change: A Very Short Introduction – Mark Maslin
7. Laboratory Manual for Meteorology – C. Donald Ahrens
8. Practical Climatology and Meteorology – T.J. Lyons and H.A. Barry
9. Meteorological Instruments and Observations – India Meteorological Department (IMD) Publication
10. Climate Science Investigations Laboratory Manual – NASA Educational Resources
11. Weather and Climate Experiments – Robert Gardner

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Generic Elective/Open Elective Paper-IV (GE-4/OE-4)**<br>**Course Code:**<br>**Course Name:** Wildlife Conservation and Management |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the students are expected to:

- To understand the fundamental principles of wildlife conservation and the ecological role of biodiversity.
- To analyze the major threats to wildlife and evaluate effective conservation strategies.
- To study wildlife management practices, population monitoring techniques, and sustainable conservation approaches.
- To explore the role of policies, communities, and NGOs in wildlife protection and conflict resolution.

**Course Outcomes (COs):** At the end of this course, the students

- CO1: Students will gain knowledge of conservation strategies, wildlife laws, and habitat management techniques.
- CO2: Students will develop skills in wildlife monitoring, ecological assessment, and conflict mitigation strategies.

| **Unit 1: Fundamentals of Wildlife Conservation** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|
| • **Introduction to Wildlife Conservation**: Definition, scope, and significance in environmental science.<br>• **Biodiversity and Ecosystem Balance**: Importance of wildlife in ecological stability, keystone species, and food webs.<br>• **Threats to Wildlife**: Habitat destruction, poaching, invasive species, climate change, and human-wildlife conflict.<br>• **Conservation Strategies**: In-situ (national parks, wildlife sanctuaries, biosphere reserves) and ex-situ (zoos, gene banks, botanical gardens) conservation methods.<br>• **Wildlife Protection Laws and Policies**: National and international regulations, Wildlife Protection Act (1972), CITES, and biodiversity conventions. | | |
| **Unit 2: Wildlife Management and Sustainable Practices** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
| • **Wildlife Habitats and Their Management**: Grasslands, wetlands, forests, marine ecosystems, and their conservation measures.<br>• **Population Dynamics and Wildlife Monitoring**: Census techniques, camera trapping, radio telemetry, and GIS applications in wildlife studies.<br>• **Role of Communities and NGOs in Wildlife Conservation**: Participatory conservation, eco-tourism, and community-based conservation models.<br>• **Human-Wildlife Conflict Management**: Strategies to mitigate conflicts, relocation, compensation policies, and conservation awareness.<br>• **Climate Change and Its Impact on Wildlife**: Shifting habitats, species extinction risks, and adaptive conservation strategies. | | |

**Textbooks and Reference Books:**


1. Primack, R. B. – Essentials of Conservation Biology
2. Sutherland, W. J. – The Conservation Handbook: Research, Management, and Policy
3. Hunter, M. L. – Fundamentals of Conservation Biology
4. Kumar, A. & Asija, M. J. – Biodiversity: Principles and Conservation
5. Mukherjee, S. – Wildlife Laws and Conservation in India

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Vocational Skill Course (VSC) Laboratory Practical-III**<br>**Course Code:**<br>**Course Name**: **Practical based on Major DSC1** |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 60<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

- To develop skills in identifying local wildlife species and understanding their ecological roles.
- To learn biodiversity survey techniques for population estimation and habitat assessment.
- To analyze threats to wildlife and evaluate conservation strategies, including legal frameworks.
- To apply wildlife management techniques, including GIS mapping and population estimation, for sustainable conservation.

**Course Outcomes (COs):** At the end of this course,: the students will gain

- CO1: Students will be able to conduct field-based wildlife surveys and assess biodiversity using scientific methods.
- CO2: Students will develop practical skills in wildlife conservation, conflict resolution, and the use of modern tools for habitat monitoring.

| **Practical based on Major DSC1** | **No. of Practical Hrs: 60** | **Weightage: 50 Marks** |
|---|---|---|

1. Identification of Local Wildlife Species – Field observation and documentation of flora and fauna.
2. Study of Keystone and Indicator Species – Analysis of species' roles in ecosystem stability.
3. Biodiversity Survey Methods – Quadrat, transect, and point count methods for population estimation.
4. Threats to Wildlife Case Studies – Analysis of habitat destruction, poaching, and invasive species through case studies.
5. Wildlife Conservation Strategies – Comparative study of in-situ and ex-situ conservation methods.
6. Analysis of Wildlife Laws and Policies – Interpretation of the Wildlife Protection Act (1972) and international conventions like CITES.
7. Wildlife Habitat Mapping Using GIS – Use of Geographic Information Systems (GIS) for habitat monitoring.
8. Population Estimation Techniques – Camera trapping, direct and indirect census methods (line transect, mark-recapture).
9. Role of Local Communities in Conservation – Case study on eco-tourism and participatory conservation.
10. Study of Human-Wildlife Conflict Cases – Analysis of real-world conflict scenarios and mitigation strategies.
11. Impact of Climate Change on Wildlife – Research-based discussion on shifting habitats and conservation adaptation.
12. Wildlife Photography & Documentation –Techniques for ethical wildlife documentation & reporting.

**Text Books / Reference Books:**


1. Sutherland, W. J. – Ecological Census Techniques: A Handbook
2. Bibby, C. J., Burgess, N. D., Hill, D. A. & Mustoe, S. – Bird Census Techniques
3. Krebs, C. J. – Ecological Methodology
4. Singh, J. S. & Singh, S. P. – Practical Manual of Environmental Science
5. Primack, R. B. – Essentials of Conservation Biology
6. Hunter, M. L. – Fundamentals of Conservation Biology
7. Mukherjee, S. – Wildlife Laws and Conservation in India
8. Kumar, A. & Asija, M. J. – Biodiversity: Principles and Conservation
9. Sodhi, N. S. & Ehrlich, P. R. – Conservation Biology for All

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Field Project (FP)-1 / Community Engagement Project (CEP)-1**<br>**Course Code:**<br>**Course Name**: **Field Project / Community Engagement Projects** |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 60<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

- To develop students' ability to identify and analyze key environmental issues through field-based research.
- To equip students with practical skills in data collection, analysis, and interpretation using scientific methods.
- To enhance community engagement by promoting awareness and participatory conservation initiatives.
- To strengthen report writing and presentation skills for effective communication of research findings.

**Course Outcomes (COs):** At the end of this course,: the students will gain

- CO1: Students will be able to conduct independent field studies and apply scientific methodologies to real-world environmental problems.
- CO2: Students will demonstrate the ability to analyze data, derive conclusions, and propose sustainable solutions for environmental conservation and management.

| Field Projects / Community Engagement Projects | No. of Practical Hrs: 60 | Weightage: 50 Marks |
|---|---|---|

**Step 1: Project Selection and Planning**

1. **Identify a Research Topic** – Choose an environmental issue relevant to local ecosystems, pollution, biodiversity, conservation, or community engagement.
2. **Set Objectives** – Define clear, measurable goals and expected outcomes of the project.
3. **Review Literature** – Conduct a preliminary study on the chosen topic using research papers, reports, and case studies.
4. **Select a Study Area** – Choose a location based on the relevance of the study, accessibility, and feasibility.

**Step 2: Methodology and Data Collection**

5. **Prepare a Work Plan** – Develop a timeline, logistics, and required resources for fieldwork.
6. **Select Appropriate Methods** – Depending on the topic, use techniques such as surveys, sampling, interviews, GIS mapping, water/soil analysis, etc.
7. **Design Data Collection Tools** – Prepare field survey sheets, questionnaires, checklists, and sampling protocols.
8. **Field Visits and Observations** – Conduct field surveys, interact with local communities, and gather primary data.
9. **Community Engagement (For CEP-1)** – Organize awareness programs, stakeholder meetings, or workshops involving the community.

**Step 3: Data Analysis and Interpretation**

10. **Compile and Organize Data** – Sort collected data in tabular, graphical, or GIS formats for better visualization.
11. **Analyze Findings** – Use statistical tools, comparative analysis, or qualitative assessment to derive meaningful insights.
12. **Compare with Existing Literature** – Relate findings with previous research or case studies.

**Step 4: Report Writing and Presentation**

13. **Prepare a Structured Report** – Include sections such as Introduction, Objectives, Methodology, Results, Discussion, Conclusion, and Recommendations.
14. **Use Visual Representations** – Add graphs, charts, maps, and photographs to support the findings.
15. **Draw Conclusions and Suggestions** – Provide solutions or recommendations based on project outcomes.

**Step 5: Presentation and Submission** – Present findings in a seminar or community meeting and submit a final report to the department

**UA**
**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**
**Faculty of Science & Technology.**
**Nature of Question Paper for CBCS Pattern NEP-2020**
**B. Sc. (Part- II )**

Time: Total Marks: 30

**Instructions**
1) All Questions are compulsory
2) Figure to right indicate full marks.

**Q.1 Choose correct alternative. (MCQ)** **06 Marks**

1)
a) b) c) d)
2)
a) b) c) d)
3)
a) b) c) d)
4)
a) b) c) d)
5)
a) b) c) d)
6)
a) b) c) d)

**Q.2. Answer the following. (Any three)** **6 (2+2+2)**

A)
B)
C)
D)
E)

**Q.3. Answer the following (Any two).** **6 (3+3)**

A)
B)
C)

**Q.4. Answer the following (Any two).** **6 (3+3)**

A)
B)
C)

**Q.5. Answer the following (Any one).** **6 Marks**

A)
B)



---

**IA/CA**
**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**
**Faculty of Science & Technology**
**Nature of Question Paper for CBCS Pattern**
**B. Sc. (Part- II)**

Time: Total Marks: 20

- **Internal Evaluation System for 20 Marks**
  - Choose any two of the following
  - Home Assignment / Unit Test / Tutorial /Seminar

---

- **Pattern of Examination:**
  - External Evaluation + Internal Evaluation
  - 30 Marks + 20 Marks = 50 Marks
  - 15 Marks + 10 Marks = 25 Marks

- **Passing Criteria:**
  - University Written Exam (UA) – 12 out of 30 and 06 out of 15
  - Internal/Continuous Assessment (IA/CA) – 08 out of 20 and 04 out of 10

---

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।
NAAC Accredited-2015
'B' Grade (CGPA 2.62)

# PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

**FACULTY: Science and Technology**

## Syllabus of

## MINOR COURSES of

## Subject: ENVIRONMENTAL SCIENCE

**For**

## Bachelor of Science (B.Sc.) Part - II

**(As per NEP-2020 pattern)**



**(To be implemented from June-2025)**

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur

## B.Sc. II, Sem-III and IV

## Vertical: Minor

## Course Name: Environmental Science

**Course Preamble**:

Education serves the vital purpose of nurturing a holistic development of an individual's personality, and the educational system plays a pivotal role in facilitating this process. Hence the objective of this course-'Environmental Science' under paper verticle Minor is intended to make the students to understand the basic concepts of environment, ecology and pollution of the current environmental issues and to participate in various activities on conserving and protecting the environment. It is designed for students interested in studying environmental problems from a scientific perspective. The syllabus of this course is prepared for third and fourth semester of B.Sc under the Faculty of all discipline of Punyashlok Ahilyadevi Holkar Solapur University, Solapur. It is multidepartmental in nature and has been framed as per UGC Model Curriculum under the Credit Framework guidelines of National Education Policy (NEP) 2020.

**Evaluation Scheme:**

2-credit Theory paper: It has 50 marks out of which 30 marks will be for Term End Examination and 20 marks for College/Internal Assessment.

1-credit Practical paper: It has 25 marks out of which 15 marks will be for Term End Examination and 10 marks for College/Internal Assessment.

Hence the candidate must appear for both internal evaluation (College Assessment) and external evaluation (University Assessment).

Nature of Question paper /pattern is as per credits prescribed by University.

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-III: Environmental Science**

**Vertical: Minor (DSC2-3) Paper-III**

**Course Code:**

**Course Name:** Environmental Issues and Case Studies

| | |
|---|---|
| ***Teaching Scheme: Credits:** 02 | ***Examination Scheme: Total Marks :** 50 |
| **Total Contact Hrs:** 30 | **UA:** 30 Marks |
| **Lectures:** 02 Hours/Week | **IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

- To analyze real-world environmental case studies and understand their causes, impacts, and management strategies.
- To develop problem-solving skills for addressing environmental challenges through case study-based learning.
- To understand environmental policies, sustainability frameworks, and management strategies for conservation.
- To encourage critical thinking and research-based approaches to environmental decision-making.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to critically evaluate environmental case studies and propose management solutions.
- CO2: Students will gain knowledge of environmental policies, conservation strategies, and sustainable resource management.

| Unit 1: **Environmental Issues and Case Studies** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Air Pollution and Its Management** – Case studies on industrial pollution, urban air quality (Delhi, Beijing), and vehicular emissions.
2. **Water Pollution and Conservation** – Case studies on river pollution (Ganga Action Plan, Yamuna River Cleanup) and groundwater depletion.
3. **Soil Degradation and Land Management** – Examples of desertification, deforestation, and soil restoration projects (Aravalli Reforestation, Watershed Management).
4. **Climate Change and Global Impact** – Case studies on rising temperatures, melting glaciers (Himalayas, Arctic), and climate adaptation strategies.
5. **Biodiversity Conservation** – Case studies on endangered species conservation (Project Tiger, Olive Ridley Turtle Conservation) and habitat restoration.

| Unit 2: **Environmental Management Strategies** | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Waste Management and Circular Economy** – Case studies on solid waste management (Swachh Bharat Abhiyan), e-waste recycling, and plastic waste control.
2. **Sustainable Energy Solutions** – Case studies on renewable energy projects (solar, wind, and hydroelectric energy initiatives).
3. **Disaster Management and Resilience** – Examples of flood control, drought mitigation, and post-disaster recovery plans.
4. **Eco-friendly and Green Initiatives** – Case studies on sustainable urban planning, green buildings, and smart cities.
5. **Community-Based Conservation and Policy Implementation** – Role of local communities, government policies, and international environmental agreements.

**Text Books / Reference Books:**


1. Cunningham, W. P., & Cunningham, M. A. – *Environmental Science: A Global Concern*
2. Miller, G. T., & Spoolman, S. – *Living in the Environment*
3. Odum, E. P. – *Fundamentals of Ecology*
4. Singh, G. B. – *Environmental Management: Principles and Case Studies*
5. Rajagopalan, R. – *Environmental Studies: From Crisis to Cure*
6. Trivedi, R. K., & Goel, P. K. – *Environmental Science and Case Studies*

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Minor (DSC2-3) Laboratory Practical-III**<br>**Course Code:**<br>**Course Name:** Environmental Issues and Case Studies |
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

- To analyze environmental case studies through hands-on practical approaches.
- To develop skills in monitoring, assessing, and managing environmental issues.
- To understand the role of environmental policies and conservation strategies in case study management.
- To apply data-driven approaches for sustainable environmental management solutions.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to assess environmental problems through field investigations and data analysis.
- CO2: Students will gain practical knowledge of sustainable environmental management techniques and policy frameworks.

| **Environmental Issues and Case Studies** | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|

**Environmental Case Studies**

1. **Air Quality Monitoring and Analysis** – Measurement of air pollutants (PM2.5, PM10, $NO_2$, $SO_2$) and comparison with national standards.
2. **Water Quality Assessment** – Analysis of pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) in local water bodies.
3. **Soil Quality and Degradation Assessment** – Testing soil texture, pH, organic matter content, and heavy metal contamination.
4. **Climate Change Data Interpretation** – Analysis of temperature variations and glacier retreat using satellite data and climate models.
5. **Biodiversity Index Calculation** – Assessment of species diversity in a local ecosystem using Shannon-Weaver or Simpson's Index.

**Environmental Management Strategies**

6. **Waste Management Audit** – Conducting waste audits in urban or rural areas and developing waste reduction strategies.
7. **Renewable Energy Potential Analysis** – Assessment of solar and wind energy potential using GIS data and field measurements.
8. **Disaster Risk Assessment** – Mapping flood-prone or drought-affected areas and proposing mitigation strategies.
9. **Green Building Case Study** – Evaluation of an existing green building project and its sustainability features.
10. **Community-Based Conservation Study** – Interaction with local communities and NGOs to document conservation initiatives.



**Text Books / Reference Books:**

1. APHA (American Public Health Association) – Standard Methods for the Examination of Water and Wastewater
2. Trivedi, R. K., & Goel, P. K. – Practical Methods in Environmental Science and Case Studies
3. Maiti, S. K. – Handbook of Methods in Environmental Studies (Vol. 1 & 2)
4. Sharma, B. K. – Environmental Chemistry and Monitoring
5. Rao, C. S. – Environmental Pollution Control Engineering

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Minor (DSC2-4) Paper-IV**<br>**Course Code:**<br>**Course Name:** Water and Land Resource Management |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the principles of water and land resource management for sustainable development.
2. To analyze water and land degradation issues and propose conservation strategies.
3. To apply scientific techniques such as GIS and remote sensing in resource management.
4. To evaluate policies and best practices in land and water resource conservation.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to assess water and land resources using analytical and field-based methods.
- CO2: Students will gain skills in applying sustainable management practices to mitigate resource degradation.

| **Unit 1:** Water Resource Management | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Introduction to Water Resources** – Types of water resources (surface water, groundwater, rainwater), availability, and distribution.
2. **Hydrological Cycle and Water Budgeting** – Components of the hydrological cycle, groundwater recharge, and water conservation.
3. **Water Quality and Pollution** – Causes, effects, and control measures of water pollution, case studies on river and groundwater contamination.
4. **Watershed Management** – Principles, components, and techniques of integrated watershed development.
5. **Sustainable Water Management Strategies** – Rainwater harvesting, groundwater recharge, water conservation policies, and climate resilience in water management.

| **Unit 2:** Land Resource Management | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

1. **Introduction to Land Resources** – Types of land use (agriculture, forest, urban, industrial), land capability classification, and degradation.
2. **Soil Conservation and Restoration** – Causes of soil erosion, soil conservation techniques, and sustainable land-use practices.
3. **Land Degradation and Management** – Desertification, deforestation, salinization, and integrated land management approaches.
4. **Remote Sensing and GIS in Land and Water Management** – Application of geospatial tools for resource mapping and monitoring.
5. **Land Use Planning and Policies** – Environmental impact assessment (EIA) for land projects, urban planning, and sustainable development goals (SDGs) in land management.



**Text Books / Reference Books:**

1. Chow, V. T. – Handbook of Applied Hydrology
2. Garg, S. K. – Water Supply Engineering
3. Das, D. C. – Hydrology and Soil Conservation Engineering
4. Murthy, J. V. S. – Watershed Management
5. Brady, N. C., & Weil, R. R. – The Nature and Properties of Soils

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Minor (DSC2-4) Laboratory Practical-IV**<br>**Course Code:**<br>**Course Name: Practical:** Water and Land Resource Management |
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To develop practical skills in assessing water and land resources using scientific techniques.
2. To analyze water quality parameters and identify pollution sources for sustainable water management.
3. To apply GIS and remote sensing techniques for land use mapping and resource planning.
4. To evaluate soil conservation techniques and watershed management strategies.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to conduct field-based assessments of water and land resources using appropriate analytical tools.
- CO2: Students will gain hands-on experience in sustainable management practices for water conservation and land degradation mitigation.

| Water and Land Resource Management | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|

**Water Resource Management**

1. **Measurement of Water pH and Quality Parameters** – Analysis of pH, turbidity, hardness, dissolved oxygen (DO), and biochemical oxygen demand (BOD).
2. **Groundwater Recharge Potential Mapping** – Assessment of groundwater recharge zones using GIS techniques.
3. **Rainwater Harvesting Model Study** – Designing and demonstrating a small-scale rainwater harvesting system.
4. **Watershed Delineation and Management Plan** – Mapping a watershed area and suggesting conservation measures.
5. **Study of Water Pollution Sources** – Field survey and documentation of industrial, agricultural, and domestic pollution sources.

**Land Resource Management**

6. **Soil Texture and Moisture Analysis** – Determination of soil texture, porosity, and moisture-holding capacity.
7. **Land Use Mapping Using Remote Sensing** – Identifying land use patterns and changes through GIS applications.
8. **Soil Erosion and Conservation Techniques** – Demonstration of soil erosion models and conservation measures.
9. **Assessment of Land Degradation** – Field survey of degraded lands and suggesting remedial measures.
10. **Impact of Land Use Change on Environment** – Case study analysis of urbanization, deforestation, or desertification.



**Text Books / Reference Books:**

1. APHA (American Public Health Association) – Standard Methods for the Examination of Water and Wastewater
2. Maiti, S. K. – Handbook of Methods in Environmental Studies (Vol. 1 & 2)
3. Das, D. C. – Hydrology and Soil Conservation Engineering
4. Rao, C. S. – Environmental Pollution Control Engineering
5. Lillesand, T., & Kiefer, R. W. – Remote Sensing and Image Interpretation

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-III: Environmental Science**<br>**Vertical: Vocational Skill Course (VSC) Laboratory Practical-II**<br>**Course Code:**<br>**Course Name**: **Practical based on Minor DSC2 :**<br>Ecotourism and Environmental Tourism |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 60<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To provide hands-on experience in identifying and assessing ecotourism destinations.
2. To develop skills in sustainable tourism planning and environmental impact assessment.
3. To understand the role of local communities in ecotourism and their socio-economic benefits.
4. To analyze ecotourism policies and suggest improvements for sustainable tourism management.

**Course Outcomes (COs):** At the end of this course,: the students will gain

- CO1: Students will gain practical experience in assessing ecotourism sites and their environmental impact.
- CO2: Students will be able to develop ecotourism management plans with a focus on sustainability and community engagement.

| **Practical based on Minor DSC2** | **No. of Practical Hrs: 60** | **Weightage: 50 Marks** |
|---|---|---|

**Fundamentals of Ecotourism and Environmental Tourism**

1. **Identification of Ecotourism Destinations** – Survey and documentation of local/national ecotourism sites.
2. **Biodiversity Assessment in Ecotourism Areas** – Field study of flora and fauna in a protected area or ecotourism site.
3. **Eco-friendly Infrastructure Evaluation** – Study of sustainable tourism infrastructure (green buildings, waste management).
4. **Ecotourism Impact Assessment** – Analysis of environmental and socio-economic impacts of tourism in a selected area.
5. **Ecotourism Policy and Regulations Review** – Interpretation of global/national ecotourism policies and their implementation.

**Ecotourism Management and Community Involvement**

6. **Sustainable Tourism Planning** – Development of a model ecotourism plan for a selected site.
7. **Visitor Management and Carrying Capacity Analysis** – Field survey and assessment of visitor impact in a tourism zone.
8. **Community-Based Ecotourism Model** – Case study and survey of local community involvement in tourism.
9. **Ecotourism Marketing and Promotion Strategies** – Study of eco-labeling, green certifications, and promotional strategies.
10. **Virtual Tour Documentation** – Creation of digital content showcasing an ecotourism site (videos, reports, presentations).



**Text Books / Reference Books:**

1. Fennell, D. A. (2020). *Ecotourism: Principles and Practices*. Routledge.
2. Weaver, D. (2014). *Sustainable Tourism: Theory and Practice*. Routledge.
3. Das, M. & Chatterjee, B. (2015). *Ecotourism: Principles, Practices, and Policies for Sustainability*. PHI Learning.
4. Honey, M. (2008). *Ecotourism and Sustainable Development: Who Owns Paradise?* Island Press.
5. Singh, S. (2003). *Tourism and Environmental Management*. Rawat Publications.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Minor (DSC2-5) Paper-V**<br>**Course Code:**<br>**Course Name:** Solid Waste Management |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the types, sources, and composition of solid waste.
2. To analyze waste management techniques, including collection, segregation, and treatment methods.
3. To evaluate sustainable waste disposal practices and their environmental impact.
4. To study waste management policies, regulations, and community-driven waste management strategies.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will be able to apply scientific methods for waste characterization and sustainable waste disposal.
- CO2: Students will develop practical solutions for waste management through recycling, waste-to-energy, and circular economy models.

| **Unit 1:** Fundamentals of Solid Waste Management | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|
| • Introduction to Solid Waste – Definition, sources, classification, and composition of solid waste.<br>• Types of Solid Waste – Municipal, industrial, hazardous, biomedical, and e-waste.<br>• Collection and Transportation – Methods, logistics, and waste collection systems.<br>• Waste Processing Techniques – Segregation, composting, incineration, and pyrolysis.<br>• Solid Waste Policies and Regulations – Waste Management Rules, Extended Producer Responsibility (EPR), and circular economy principles. | | |
| **Unit 2:** Advanced Waste Management and Sustainable Practices | **Contact Hrs-15** | **Weightage: ~23 Marks** |
| • Recycling and Resource Recovery – Technologies for material recovery and recycling.<br>• Waste Treatment and Disposal – Sanitary landfills, leachate management, and bioremediation.<br>• Waste-to-Energy Technologies – Biogas production, refuse-derived fuel (RDF), and thermal treatment.<br>• Sustainable Waste Management Strategies – Zero-waste initiatives, community participation, and corporate responsibility.<br>• Case Studies in Solid Waste Management – Successful waste management models (e.g., Swachh Bharat Abhiyan, international case studies). | | |

**Text Books / Reference Books:**


1. Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). Integrated Solid Waste Management: Engineering Principles and Management Issues. McGraw-Hill.
2. Sharma, S. K. & Bhardwaj, S. (2019). Solid Waste Management: An Indian Perspective. I.K. International.
3. Kreith, F. & Tchobanoglous, G. (2002). Handbook of Solid Waste Management. McGraw-Hill.
4. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill.
5. Agarwal, R. & Garg, S. (2016). Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press.

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**

**B.Sc. Part-II, SEM-IV: Environmental Science**

**Vertical: Minor (DSC2-5) Laboratory Practical-V**

**Course Code:**

**Course Name: Practical:** Solid Waste Management

| | |
|---|---|
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the sources, classification, and characteristics of solid waste.
2. To study waste collection, transportation, and processing techniques for effective management.
3. To explore sustainable waste disposal and recycling methods, including composting and waste-to-energy technologies.
4. To analyze policies, regulations, and community-based strategies for solid waste management.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will gain practical knowledge in solid waste analysis, treatment, and sustainable waste management solutions.
- CO2: Students will develop skills in waste recycling, composting, and biogas production for environmental sustainability.

| **Solid Waste Management** | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|

Fundamentals of Solid Waste Management

1. Characterization of Solid Waste – Analysis of composition and classification of municipal solid waste.
2. Determination of Moisture Content in Solid Waste – Laboratory analysis of moisture percentage in different waste samples.
3. Composting Techniques – Demonstration of aerobic and anaerobic composting methods.
4. Survey on Household and Industrial Waste Generation – Field study on waste generation patterns and management practices.
5. Study of Waste Collection and Transportation Systems – Observation of municipal waste collection routes, bins, and transport methods.

Advanced Waste Management and Sustainable Practices

6. Plastic Waste Recycling Study – Examination of plastic waste segregation, recycling, and reuse techniques.
7. Vermicomposting Demonstration – Setting up and monitoring a vermicomposting unit for organic waste.
8. Biogas Production from Organic Waste – Experimental setup for anaerobic digestion and methane production.
9. Leachate Testing from Landfills – Analysis of pH, heavy metals, and organic contaminants in landfill leachate.
10. Case Study on Successful Waste Management Practices – Report on waste-to-energy plants, zero-waste cities, or e-waste recycling initiatives.

**Text Books / Reference Books:**


1. Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). Integrated Solid Waste Management: Engineering Principles and Management Issues. McGraw-Hill.
2. Gupta, P. K. (2017). Methods in Environmental Analysis: Water, Soil and Air. Agrobios.
3. Agarwal, R. & Garg, S. (2016). Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press.
4. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environ. Engineering. McGraw-Hill.
5. Manser, A. G. R. & Keeling, A. A. (1996). Practical Handbook of Processing and Recycling Municipal Waste. CRC Press.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Minor (DSC2-6) Paper-VI**<br>**Course Code:**<br>**Course Name:** Environmental Microbiology |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 30<br>**Lectures:** 02 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To understand the role of microorganisms in natural and human-influenced environments.
2. To explore microbial interactions in ecosystems and their impact on biogeochemical cycles.
3. To study applied aspects of microbiology, including bioremediation, wastewater treatment, and biofertilizers.
4. To analyze microbial techniques for environmental monitoring and pollution control.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will develop knowledge of microbial diversity, ecological interactions, and their environmental significance.
- CO2: Students will gain practical skills in microbial isolation, identification, and environmental applications.

| **Unit 1:** Fundamentals of Environmental Microbiology | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Introduction to Environmental Microbiology** – Scope, importance, and role of microbes in the environment.
- **Microbial Diversity and Classification** – Bacteria, fungi, viruses, algae, and protozoa in soil, water, and air.
- **Microbial Ecology and Interactions** – Symbiosis, mutualism, commensalism, and microbial food webs.
- **Role of Microbes in Biogeochemical Cycles** – Carbon, nitrogen, sulfur, and phosphorus cycles.
- **Microbial Degradation of Pollutants** – Biodegradation, bioremediation, and microbial consortia.

| **Unit 2:** Applied Environmental Microbiology | **Contact Hrs-15** | **Weightage: ~23 Marks** |
|---|---|---|

- **Water Microbiology** – Indicator microorganisms, waterborne diseases, and water quality testing.
- **Soil Microbiology** – Role of microbes in soil fertility, composting, and organic matter decomposition.
- **Airborne Microorganisms** – Microbial aerosols, indoor air quality, and bioaerosols.
- **Microbial Biotechnology for Environmental Management** – Bioremediation, biofertilizers, and wastewater treatment.
- **Microbial Pathogens and Public Health** – Pathogenic microorganisms in the environment and their control.



**Text Books / Reference Books:**

1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). Microbiology: Concepts and Applications. McGraw-Hill.
2. Prescott, L. M., Harley, J. P., & Klein, D. A. (2017). Microbiology. McGraw-Hill Education.
3. Atlas, R. M., & Bartha, R. (1998). Microbial Ecology: Fundamentals and Applications. Pearson.
4. Bitton, G. (2010). Wastewater Microbiology. Wiley-Blackwell.
5. Maier, R. M., Pepper, I. L., & Gerba, C. P. (2009). Environmental Microbiology. Academic Press.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Minor (DSC2-6) Laboratory Practical-VI**<br>**Course Code:**<br>**Course Name: Practical:** Environmental Microbiology |
| ***Teaching Scheme: Credits:** 01<br>**Total Contact Hrs:** 30<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 25<br>**UA:** 15 Marks<br>**IA/CA:** 10 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To develop hands-on skills in microbial culturing and staining techniques.
2. To apply microbiological methods for water, soil, and air quality assessment.
3. To study microbial degradation and bioremediation techniques.
4. To analyze environmental samples for microbial diversity and activity.

**Course Outcomes (COs):** At the end of this course,:

- CO1: Students will acquire laboratory techniques for microbial analysis in environmental samples.
- CO2: Students will apply microbiological tools to assess environmental quality and pollution control.

| **Environmental Microbiology** | **No. of Practical Hrs: 60** | **Weightage: 25 Marks** |
|---|---|---|

Fundamentals of Environmental Microbiology

1. Isolation and Culturing of Microorganisms – Streak plate, pour plate, and spread plate techniques.
2. Gram Staining and Microscopic Observation – Identification of bacteria using gram staining.
3. Estimation of Microbial Load in Soil and Water – Serial dilution and colony count methods.
4. Examination of Microbial Biofilms – Study of biofilm formation on different surfaces.
5. Testing for Biodegradation of Pollutants – Analysis of microbial degradation of organic matter.

Applied Environmental Microbiology

6. Detection of Coliform Bacteria in Water – Most Probable Number (MPN) and membrane filtration techniques.
7. Airborne Microbial Sampling and Identification – Air sampling and enumeration of airborne microbes.
8. Soil Microbial Activity Test – Enzyme activity assays (dehydrogenase, phosphatase).
9. Composting and Microbial Decomposition Study – Analysis of compost microbial community.
10. Bioremediation Experiment Using Microbial Consortia – Removal of pollutants from contaminated water or soil.

**Text Books / Reference Books:**


1. Cappuccino, J. G., & Welsh, C. (2017). Microbiology: A Laboratory Manual. Pearson.
2. Aneja, K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International.
3. Gerhardt, P., et al. (1994). Methods for General and Molecular Bacteriology. American Society for Microbiology.
4. Madigan, M. T., Martinko, J. M., & Stahl, D. A. (2015). Brock Biology of Microorganisms. Pearson.

| | |
|---|---|
| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**B.Sc. Part-II, SEM-IV: Environmental Science**<br>**Vertical: Vocational Skill Course (VSC) Laboratory Practical-IV**<br>**Course Code:**<br>**Course Name**: **Practical based on Minor DSC2 :**<br>ENVIRONMENTAL AWERENESS |
| ***Teaching Scheme: Credits:** 02<br>**Total Contact Hrs:** 60<br>**Practical:** 04 Hours/Week | ***Examination Scheme: Total Marks :** 50<br>**UA:** 30 Marks<br>**IA/CA:** 20 Marks |

**Course Objectives:** During this course, the student is expected to:

1. To analyze and interpret ecological relationships through food chains, food webs, and ecological pyramids.
2. To develop skills in biodiversity assessment and mapping of natural resources using maps and other tools.
3. To understand different ecosystems, including desert, grassland, and forest, through visual representation and specimen study.
4. To enhance environmental awareness by engaging in practical activities related to conservation and sustainability.

**Course Outcomes (COs):** At the end of this course,: the students will gain

1. CO1: Students will be able to identify and explain ecological interactions, ecosystem structures, and biodiversity distribution.
2. CO2: Students will gain hands-on experience in environmental assessment, mapping techniques, and community-based awareness activities.

| **Practical based on Minor DSC2** | **No. of Practical Hrs: 60** | **Weightage: 50 Marks** |
|---|---|---|

1. To study food chain and food web using photographs/chart/specimen.
2. To study ecological pyramids using photographs/chart/specimen.
3. To study biodiversity hotspots of world and India using Map.
4. To study natural resources mapping of suggested area instructed by teacher.
5. To study atmosphere, lithosphere and hydrosphere using digital and nondigital images.
6. To study dessert ecosystem using photographs/chart/specimen.
7. To study grassland ecosystem using photographs/chart/specimen.
8. To study forest ecosystem using photographs/chart/specimen.
9. To perform any one environmental awareness activity suggested by the teacher and prepare report of it.

**Text Books / Reference Books:**


1. Covers ecological concepts, food chains, food webs, and ecosystem dynamics.
2. Smith, T. M., & Smith, R. L. (2012). *Elements of Ecology*. Pearson Education.
3. Provides details on ecological pyramids, biodiversity, and ecosystem functions.
4. Miller, G. T., & Spoolman, S. E. (2015). *Living in the Environment*. Cengage Learning.
5. Explains atmosphere, lithosphere, and hydrosphere interactions with ecosystems.
6. Begon, M., Townsend, C. R., & Harper, J. L. (2006). *Ecology: From Individuals to Ecosystems*. Wiley-Blackwell.
7. Covers ecosystem structure, desert, grassland, and forest ecosystems.
8. Misra, K. C. (2010). *Manual of Environmental Science and Engineering*. Prentice-Hall India.
9. Includes practical methodologies for environmental mapping and awareness activities.
10. Kumar, H. D. (2001). *Biodiversity and Sustainable Conservation*. Oxford & IBH Publishing.
11. Discusses biodiversity hotspots of India and the world with mapping techniques.
12. Dash, M. C. (2004). *Fundamentals of Ecology*. Tata McGraw-Hill.
13. Explains natural resource mapping and ecosystem studies with practical approaches.
14. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, Environmental Science & Conservation*. S. Chand Publishing. Focuses on ecological principles, environmental awareness, and conservation methods.

**UA**
**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**
**Faculty of Science & Technology.**
**Nature of Question Paper for CBCS Pattern NEP-2020**
**B. Sc. (Part- II )**

Time: Total Marks: 30

**Instructions**
1) All Questions are compulsory
2) Figure to right indicate full marks.

**Q.1 Choose correct alternative. (MCQ)** **06 Marks**

1)
a) b) c) d)
2)
a) b) c) d)
3)
a) b) c) d)
4)
a) b) c) d)
5)
a) b) c) d)
6)
a) b) c) d)

**Q.2. Answer the following. (Any three)** **6 (2+2+2)**

A)
B)
C)
D)
E)

**Q.3. Answer the following (Any two).** **6 (3+3)**

A)
B)
C)

**Q.4. Answer the following (Any two).** **6 (3+3)**

A)
B)
C)

**Q.5. Answer the following (Any one).** **6 Marks**

A)
B)

---

**IA/CA**
**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**
**Faculty of Science & Technology**
**Nature of Question Paper for CBCS Pattern**
**B. Sc. (Part- II)**

Time: Total Marks: 20

- **Internal Evaluation System for 20 Marks**
  - Choose any two of the following
  - Home Assignment / Unit Test / Tutorial /Seminar

---

- **Pattern of Examination:**
  - External Evaluation + Internal Evaluation
  - 30 Marks + 20 Marks = 50 Marks
  - 15 Marks + 10 Marks = 25 Marks

- **Passing Criteria:**
  - University Written Exam (UA) – 12 out of 30 and 06 out of 15
  - Internal/Continuous Assessment (IA/CA) – 08 out of 20 and 04 out of 10

---