



Savitribai Phule Pune University

(Formerly University of Pune)

Under Graduate Degree Program in Environmental Science
(B.Sc. Environmental Science)
(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for F.Y.B.Sc.
Environmental Science (Semester-I and II)
(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

To Be Implemented From

Academic Year 2024-25

Formed by

BOARD OF STUDIES IN ENVIRONMENTAL SCIENCE (Adhoc)
Savitribai Phule Pune University, Pune
Ganeshkhind, Pune – 7

Aim and Objective:

The primary aim of the B.Sc. Environmental Science course is to:

1. To develop a thorough understanding of environmental systems and the human impact on these systems.
2. To equip students with the skills needed to analyse, monitor, and manage the environment sustainably.
3. To foster critical thinking and problem-solving abilities related to environmental challenges.
4. To develop employability-oriented diversified course content.

Program Outcomes (POs)

Aligned with NEP-2020, the B.Sc. Environmental Science program at Savitribai Phule Pune University and its associated colleges equips students with a comprehensive understanding of environmental systems and contemporary challenges. Integrating core environmental science courses with multidisciplinary minors fosters a holistic grasp of environmental issues that encompasses social sciences, economics, and policy. Open elective courses, allowing students to tailor their learning to specific environmental interests, like climate change, biodiversity conservation, or pollution management. Skill enhancement courses, equipping graduates with practical skills in environmental monitoring, data analysis, and field research for real-world environmental careers.

This holistic curriculum cultivates graduates who are knowledgeable in both fundamental and advanced environmental science principles, outcome-oriented with critical thinking and problem-solving skills to address pressing environmental issues, skilled practitioners are adept at applying theory through fieldwork, lab analysis, and data interpretation, tech-savvy in utilizing e-learning, flipped classrooms, and blended learning environments, and environmentally responsible, committed to sustainable practices for a greener future. These well-rounded graduates will be instrumental in propelling India towards environmental leadership on the global stage.

After successful completion of the Undergraduate (UG) Degree program, the students would be able to:

PO1: Attain thoughtful proficiency in the field of environmental science.

PO2: Acquire the ability to integrate knowledge across multidisciplinary domains.

PO3: Apply scientific knowledge to investigate and solve environmental issues.

PO4: Develop ethical awareness and commitment to professional standards.

PO5: Foster skills for self-directed, lifelong learning in the 21st century.

PO6: Apply environmental science knowledge in diverse contexts with a global perspective.

PO7: Develop personal and professional maturity to pursue environmental science careers.

1. Title of the Course: B.Sc. Environmental Science (03 Years) / B.Sc. With Honours in Environmental Science (04 Years)

The syllabus was revised as per National Education Policy (NEP) 2020 for the Colleges Affiliated with Savitribai Phule Pune University, Pune.

2. Faculty:- Science and Technology

3. To be implemented for F.Y.B.Sc. Environmental Science (Semester I and Semester II) from the academic year 2024-25

4. Preamble:

The B.Sc. Environmental Science program at Savitribai Phule Pune University, Pune is designed to equip students with a comprehensive understanding of the environment and the complex interactions between human activities and natural systems. As we face unprecedented environmental challenges such as climate change, biodiversity loss, pollution, and resource depletion, the need for skilled environmental scientists has never been greater. This program aims to produce well-prepared graduates to address these challenges through scientific knowledge, practical skills, and ethical responsibility.

This undergraduate program provides a strong foundation in the core principles of environmental science, integrating knowledge from biology, chemistry, physics, earth sciences, and social sciences. Students will thoroughly understand ecological processes, environmental sustainability, and the socio-economic factors influencing environmental policies and management strategies.

The program fosters critical thinking, problem-solving, and innovation through rigorous coursework, hands-on laboratory and field experiences, interdisciplinary minor courses, and vocational skills training. Students will be trained in modern environmental monitoring techniques, data analysis, and the application of scientific methods to real-world problems. The curriculum also emphasizes the importance of ethical practices, professional standards, and a commitment to lifelong learning.

The B.Sc. Environmental Science program aims to nurture responsible citizens and future leaders who can contribute to sustainable development and environmental stewardship at local, national, and global levels. Graduates will be prepared for diverse careers in environmental science, research, policy-making, education, and industry and advanced studies in specialized fields.

As part of the program, students will engage with recent pedagogical trends in education, including E-learning, flipped classrooms, hybrid learning, and experiential learning. These approaches ensure that our graduates are knowledgeable but also adaptable, innovative, and capable of addressing the dynamic challenges of the 21st century.

By fostering a deep appreciation for the environment and equipping students with the necessary tools to protect and sustain it, the B.Sc. Environmental Science program at Savitribai Phule Pune University, Pune aspires to create a better future for all.

Program Structure for B.Sc. Environmental Science

The UG Program in Environmental Science is designed to provide flexibility and multiple exit options to accommodate students' varying academic and career goals. The program is structured as follows:

Duration: Four Years (Eight Semesters): The full B.Sc. Environmental Science program.

Exit Options:

1. **Undergraduate Certificate:** Students who exit after the first year (two semesters) will receive a UG Certificate based on completed credits.
2. **Undergraduate Diploma:** 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:** Students may leave the program after completing the third year (six semesters) to receive a three-year undergraduate degree.

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.

Credit Requirements:

1. Minimum Credits per Semester: 18 credits
2. Maximum Credits per Semester: 26 credits
3. Recommended Credits per Semester: 22 credits

This flexible semester-based course load is designed to give students the comfort of managing their academic workload according to their personal and professional commitments.

Table 1: Credit Requirements

Sr. No.	Type of Award	Stage of Exit	Mandatory Credits
1.	Undergraduate Certificate in Environmental Science	After successful completion of First year Semesters	44
2.	Undergraduate Diploma in Environmental Science	After successful completion of Second year Semesters	88
3.	Bachelor of Science in Environmental Science	After successful completion of Third year Semesters	132
4.	Bachelor of Science in Environmental Science (Honours)	After successful completion of Third year Semesters	176

5. Eligibility Criteria -

The basic criteria for admission to an undergraduate degree (F.Y.B.Sc. Environmental Science) will be 10+2, with Biology, Physics, Chemistry, Mathematics, and Geography as principal subjects. Admissions will be given as per the selection procedure/policies adopted by the college, keeping with the conditions laid down by the Savitribai Phule Pune University, Pune. Reservation and relaxation are as per the State Government rules.

6. **Fee Structure** – As per the norms of Savitribai Phule Pune University, Pune.

7. Duration of the Course

Certificate Course- 01 year (Completion of 02 Semesters)

Diploma Course- 02 years (Completion of 04 Semesters)

BSc Degree- 03 years (Completion of 06 Semesters)

BSc Degree with Honours- 04 years (Completion of 08 Semesters)

8. **No of semesters** – Two semesters per year

9. **Medium of instructions and teaching:** English

10. Course Implementation criteria for Theory and Practical:

- Each semester comprises of 15 weeks (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).
- One Credit of the Theory** is equal to 15 clock hours (Teaching 1 hour per week for each credit, 12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.

- c. **One Credit of Practical** = 30 clock hours. (2 Contact hours per credit per week)
One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for journal competition and Continuous Internal Evaluation of each practical).
- d. **Practical for each course comprises of 02 Credits = 60 clock hours.** Therefore,
- At least 12 laboratory sessions of 04 clock hours must be conducted in one semester.
 - In the case of short practicals, two practicals should be conducted in one session.
 - Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
 - Pre-laboratory reading and post-laboratory assignments should be given on each practical as a part of continuous internal evaluation.

11. Examination Pattern (For each Semester): The examinations will be conducted

Semester-wise for both theory and practical courses.

➤ **Theory Paper of 02 Credits –**

- Internal Exam (15 M) + University Theory Exam (35 M) = Total 50 M
- Duration: For Internal exam = 40 Min. and For University Exam = 02 hours.

➤ **Practical Paper of 2 Credits -**

- Internal Exam (15 M) + University Practical Exam (35 M) = Total 50 M
- Duration: For the Internal exam = 40 Min. and For the University Exam = More than 04 hours.

12. **Award of Class/Grade:** The class / grade for the courses of each semester will be followed as per the norms and conditions laid down by SPPU, Pune.

13. **ATKT Rules:** As per the norms given by SPPU, Pune

14. Important Note:

- a. There shall be at least a short study tour/field visit/industrial visit (1-2 days) per year for all UG students. Study tours are the part of curriculum and obligatory to each student, failing which they will not be considered eligible to appear for the practical examination.
- b. Under unavoidable circumstances, if the student fails to attend the tour, he/she have to produce justifiable evidence for not attending the study tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.
- c. The documents to be produced by each student at the time of practical examination (at the end of each Semester) are:

- Submission of practical records (Journals).
- Submission of a Tour / Visit report duly signed by the concerned practical Incharge and Head of the Department.
- Any submissions/assignments, etc., based on the practical course.

Question paper pattern for Theory (2 Credit courses)

A student will have to solve the question paper for 35 marks. The paper setter should set the paper on the entire syllabus for a total of 61 marks, including optional questions. As the course is of 2 Credits (30 clock-hour lectures), the paper setter should allot 2.03 marks per lecture, and accordingly, questions should be set for 30 lectures, 61 marks on the entire syllabus.

Note: All questions are compulsory.

Time: 2 Hours

Que. 1) Answer any five of the following in one sentence 05 Marks

- Six questions
- Each for 1 mark

Que. 2a) Write any one of the following 06 Marks

- i.
- ii.

Que. 2b) Write any one of the following 04 Marks

- i.
- ii.

Que. 3a) Solve any one of the following 06 Marks

- i.
- ii.

Que. 3b) Solve any one of the following 04 Marks

- i.
- ii.

Que. 4) Write notes on (Any four) 10 Marks

- a.
- b.
- .c.
- d.
- e.
- f

Credit Framework for Under Graduate (UG) B.Sc. Environmental Science (2024-2025)

Subject Code: EVS

Level/ Difficulty	Sem	Subject-1 (1T + 1P) x 2 C = 4 C	Subject-2	Subject-3	Generic Elective (GE) / Open Elective (OE)	Skill Enhancement Courses (SEC)	IKS	AEC	VEC	CC	Total
4.5/ 100	I	<p>EVS-101-T Fundamentals of Environmental Biology [2 T]</p> <p>EVS-102-P Environmental Science Practical-I [2 P]</p>	2(T) + 2(P)	2(T) + 2(P)	<p>OE-101-EVS-T Environmental Pollution [2 T]</p> <p>Or</p> <p>OE-102-EVS-T Wildlife of India [2 T]</p>	<p>SEC-101-EVS Environmental Geosciences [2 T]</p>	2 (T) Generic	2 (T)	VEC-101-T Environmental Education [2 T]	-	22
	II	<p>EVS-151-T Fundamentals of Environmental Physics and Geochemistry [2 T]</p> <p>EVS-152-P Environmental Science Practical-II [2 P]</p>	2(T) + 2(P)	2(T) + 2(P)	<p>OE-151-EVS-P Practical in Environmental Pollution [2 P]</p> <p>OR</p> <p>OE-152-EVS-P Practical in Wildlife of India [2 P]</p>	<p>SEC-151-EVS Fundamentals of Environmental Pollution [2 T]</p>		2 (T)	VEC-151-T Environmental Education [2 T]	Any one from basket	22
<p>Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits Course NSQF courses/Internship OR Continue with Major and Minor</p> <p>Continue Option: Students will select one subject among the (subject-1, subject-2 and subject-3) as a major and another as minor and third subject will be dropped.</p>											

F.Y.B.Sc. Environmental Science (Semester-I)**Course Code – EVS-101-T****Course Title: Fundamentals of Environmental Biology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****Objectives:**

1. To introduce students to the fundamental concepts of biology and its importance in the environmental context.
2. To provide an understanding of the origin and evolution of life through geological times.
3. To analyze the factors affecting the distribution of life on Earth.
4. To comprehend the principles and systems of taxonomy.
5. To explore ecological adaptations and the significance of bio-resources.

Course Outcome:

Upon completion of this course, students will be able to:

1. Describe the branches and scope of biology, emphasizing its environmental importance and Darwin's contributions.
2. Outline the origin and evolution of life and major evolutionary events, and analyse the current mass extinction crisis.
3. Understand factors influencing the distribution of life and describe the characteristics of biogeographical zones.
4. Explain taxonomic hierarchy and compare historical classification systems and species concepts.
5. Identify ecological adaptations and assess the significance and threats to bio-resources.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Biology	<ul style="list-style-type: none"> • Introduction to Biology, Branches, Scope and Importance in today's context from environmental point of view. • Charles Darwin's Voyage of HMS Beagle His theory of 'Survival of the Fittest'. Biological diversity of India – Major genera, species, sub-species of flora and fauna. Major ecological types of India 	06
2	Origin of Life	<ul style="list-style-type: none"> • The origin of Life; Evolution of Life through the geological time i.e. – Eras, Periods, Epochs; Events of (Evolutionary) 'Explosions' and 'Mass Extinctions' & Paleontological Evidences for these. • The current 'Mass Extinction' with reference to rate of extinction, factors responsible and possible remedies. 	06
3	Biogeography	<ul style="list-style-type: none"> • A glimpse of the present day distribution of Life on Earth; The factors responsible – <ol style="list-style-type: none"> i) Geological - Continental Drift- Barriers and Bridges, ii) Climatic - Barriers and Bridges, iii) Evolutionary - Speciation etc. • Biogeography – The meaning; Biographical profile of the world; The physical, microbial, floral and faunal characteristics of each Bio geographical zone. 	06

4	Taxonomy	<ul style="list-style-type: none"> • Taxonomic Principles - aim, objectives, hierarchy, kingdoms. • History; Linnaeus system of classification; Bentham & Hooker system of classification. • Components of systematic - characterization, classification, identification & nomenclature. • The concept of species:- morphological, biological, phylogenetic, ecological etc. 	06
5	Ecology and Bioresources	<ul style="list-style-type: none"> • Ecological Adaptations under various environmental conditions – <ol style="list-style-type: none"> i) In plants - hydrophytes, mesophytes, epiphytes, xerophytes & halophytes ii) In animals - mimicry, vestigiality etc. • Bio-resources--- <ol style="list-style-type: none"> i) Forests- major types of the world & India ii) Agricultural crops - major food plants of the world & India iii) Livestock – major varieties of the world & India iv) Fisheries resources - saline & fresh water • Significance/use of the Bioresources; Extraction of Bioresources by traditional & modern methods; Threat to local Bioresources - overexploitation, habitat loss, invasive species etc. 	06

Reference Books –

- 1) 'A Textbook of Plant Ecology' Ambashta R.S. & Ambashta N.K (1999) CBS Publ. & Distributers, New Delhi
- 2) 'Ecology: Principles and Applications' Chapman J.L. & Reiss M.J. (1995) Cambridge University Press
- 3) 'Environmental Science: A Global Concern' Cunningham W.P. & Saigo S.W. (1997) WCB, McGraw Hill
- 4) 'Elements of Ecology' Sharma P.D. Rastogi Publication
- 5) 'Environmental Science' Tyler M.G. Jr. (1997) Wadsworth Publ. Co.
- 6) 'Environmental Studies' Benny Joseph (2005) Tata McGraw Hill Publ. Co. Ltd.
- 7) 'Patterns in the Living World' – Biology-an Environmental approach, John Murray, London
- 8) 'Diversity Among Living Things' Biology-an Environmental approach, John Murray, London
- 9) 'Paleobotany and the Evolution of Plants' Wilson N. Stewart (1983) Cambridge University Press
- 10) Biological science, D. J. Taylor, N.P.O. Green & G.W Stout, Cambridge Low Price Edition, 3rd Edtn.
- 11) Holmes' Principles of Physical Geology, Edt. By P. McL. D. Duff, ELBS with Chapman & Hall, 4th Edtn.
- 12) An Advanced textbook on Biodiversity – Principles & Practice, K. V. Krishnamurthy, Oxford & IBH Publishing Co. Pvt. Ltd., Special Indian Edtn

F.Y.B.Sc. Environmental Science (Semester-I)**Course Code – EVS-102-P****Course Title: Environmental Science Practical - I****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Objectives:****Course:**

1. To enable students to acquire practical fieldwork skills for documenting local flora and fauna, including identification techniques and biodiversity assessment methods.
2. To provide students with a comprehensive understanding of plant and animal adaptations to various environmental conditions, emphasizing these adaptations' evolutionary mechanisms and ecological significance.
3. To equip students with taxonomic skills, including species identification, classification, and using taxonomic keys, to facilitate their participation in biodiversity research and conservation initiatives.
4. To enable students to comprehend biogeographical concepts such as species distribution patterns, continental drift, and speciation processes, fostering an appreciation for the interconnectedness of geological, climatic, and evolutionary factors shaping biodiversity.

Outcome

Upon completion of this course, students will be able to:

1. Demonstrate proficiency in fieldwork techniques for biodiversity surveys and ecological assessments.
2. Exhibit a comprehensive understanding of plant and animal adaptations, enhancing interpretation of ecological interactions.
3. Acquire species identification and classification proficiency, supporting biodiversity research and conservation efforts.
4. Gain insight into biogeographical processes, facilitating interpretation of global biodiversity patterns.
5. Apply knowledge of resource management for informed decision-making and conservation efforts.

Sr. No.	Practical Title	Practical Sessions
1.	Introduction to Laboratory safety rules and introduction to laboratory equipment	1
2.	Identify and document local flora and fauna, focusing on major genera and species. (Field Practical)	1
3.	Study of Plant Adaptations under various environmental conditions (Hydrophytes, Mesophytes, Epiphytes, Halophytes & Xerophytes).	1
4.	Study of Animal Adaptations under various environmental conditions (Structural: Camouflage, mimicry, Vestigiliaty. Behavioural: Hibernation, Migration,	1
5.	Identifying native plants for plantation with respect to Geography and Climate	1
6.	Estimate plant species richness by using the transact/quadrante method	

7.	Estimate the relative abundance of plant/animal species by using the transect/quadrant method.	
8.	Determine plant species distribution (clumped together, randomly scattered, or arranged in a specific pattern) by using the transect/quadrant method.	
9.	Estimate Diversity Index (Simpson's Diversity Index and Shannon-Wiener Diversity Index) of plant/animal species	
10.	Examination of fossil samples to understand the evolutionary history and major geological periods.	1
11.	Conduct/demonstrate a laboratory experiment to simulate the conditions of early Earth and discuss the origin of life.	1
12.	Use maps and models to understand the concept of continental drift and its impact on the distribution of life.	1
13.	Investigation of how climatic barriers and bridges affect species distribution (e.g., temperature, precipitation).	1
14.	Practical exercises on understanding speciation processes through examples and simulations.	1
15.	Practical on the use of taxonomic keys to classify plant and animal specimens.	1
16.	Study of Linnaean, Bentham & Hooker systems of classification through practical examples.	1
17.	Practical exercises to distinguish between morphological, biological, phylogenetic, and ecological species concepts.	1
18.	Field visits to study and document different forest types in the local area.	1
19.	Practical identification and study of major food plants used in agriculture.	1
20.	Visit local markets to study and document saline and freshwater fishery resources.	1
21.	Examination and documentation of different livestock varieties in the local region.	1

Note: Conduct any 15 practical's from the above mentioned list

F.Y.B.Sc. Environmental Science (Semester-I)**Option 1****Course Category: Open Elective (OE) / Generic Elective (GE)****Course Code – OE-101-EVS****Course Title: Environmental Pollution****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****Objectives**

- To provide students with a comprehensive understanding of various types of environmental pollution, their sources, and their impacts on ecosystems and human health.
- To create awareness among students about the seriousness of environmental pollution and the need for sustainable development.
- To develop the ability to analyze and assess environmental pollution issues using scientific principles and data.
- To introduce students to environmental policies, regulations, and management strategies aimed at controlling and mitigating pollution.
- To equip students with the knowledge and skills necessary to propose and evaluate solutions to pollution problems.

Outcomes:

Upon completion of this course, students will be able to:

- Identify different types of environmental pollution (air, water, soil, noise, etc.) and describe their sources and effects.
- Analyze environmental data and evaluate the extent and severity of pollution in various environmental contexts.
- Understand the impacts of pollution on ecosystems, biodiversity, and human health, and discuss case studies illustrating these impacts.
- Demonstrate knowledge of environmental laws, policies, and regulatory frameworks aimed at controlling pollution.
- Propose and assess potential solutions and strategies for pollution prevention and control, considering technical and policy-oriented approaches.
- Advocate for sustainable practices and engage in informed discussions about environmental issues, contributing to community and societal well-being.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction	Pollution – Definition; Types – Air, Water Soil, Noise, Thermal, Radioactive and Solid waste, Natural and Anthropogenic	04
2	Air Pollution	Definition, historical context, Types of Pollutants (Primary and Secondary), Sources of pollution (Natural, Anthropogenic), health impacts (Short term and Long term), environmental effects (ecosystem, water bodies, atmosphere, buildings), measurement and monitoring, control measures and technologies. Case study (London Smog, Los Angeles Smog)	06

3	Water pollution	Definition, historical context, types of pollutants (Organic, inorganic, microbial nutrient, physical etc), Sources (Point and Non-Point), health effects (waterborne diseases, acute and chronic effects), Environmental effects (ecosystem, eutrophication, acidification, bioaccumulation and bio magnification), measurement and monitoring (physicochemical and biological parameters), regulations and policies, wastewater treatment, case study (River Pollution)	06
4	Soil pollution and Solid waste	Definition, historical context, types of pollutants (Organic, inorganic, persistent organic pollutants (POSs), Sources of Pollution (agriculture and industrial activities, urbanization, accidental spills), Health and environmental impacts, soil health indicators, soil sampling, laboratory analysis, organic farming, case study (mining, waste dumping etc) Solid waste: definition, types, sources, environmental and health impacts, Management Strategies: 3R, composting, landfill, incineration, waste to energy, policy and regulation, case study	08
5	Noise and Radiation, Thermal Pollution	Noise Pollution: Definition, Historical context, Sources, physical and psychological impacts, noise measurement, noise control measures: sound barriers, insulations, urban planning, zoning law and traffic management, PPE Kit, etc., Radiation Pollution: Definition, Historical context, types of radiation (ionizing and non-ionizing), sources (Natural, anthropogenic), health and environmental impacts (acute, chronic, etc), case study (Chernobyl, Fukushima) Thermal pollution: Definition, Historical context, Sources, effects, mitigation strategies: cooling tower, cooling pond, spray tower,	06

Reference Books -

- 1) Air Pollution- M. N. Rao & H.V.N. Rao; Tata McGraw Hill, New Delhi, 1989.
- 2) "Environment Pollution Control and Environmental Engg." C. S. Rao, Tata McGraw Hill, New Delhi, 1994.
- 3) Soil pollution & Soil Organism - P.V. Mishra
- 4) Water Pollution—A.K. Tripathy & S.N. Pandey; A. P. H. Publishing Corporation
- 5) Environmental Air pollution & it's control—G.R. Chatwal; Anmol Publications, New Delhi, 1989
- 6) Environmental Chemistry; A. K. De; New Age International Publishers; 6thEdtn.
- 7) Understanding Environment; Edt by Kiran B. Chhokar, Mamata Pandya, Meena Raghunathan; Centre for Environment Education; Sage Publication.
- 8) Perspective in Environmental Studies; Kaushik & Kaushik; New Age International Pvt. Ltd Publishers
- 9) Environmental Science; S. C. Santra; New Central Book Agency (P) Ltd.; 2ndEdtn.
- 10) Water Pollution, P.K. Goel, New Age International, 2006 Revised Edtn

F.Y.B.Sc. Environmental Science (Semester-I)

Option 2

Course Category: Open Elective (OE) / Generic Elective (GE)

Course Code – OE-102-EVS

Course Title: Wildlife of India

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

Objectives:

1. To grasp fundamental concepts of wildlife of India
2. To classify wildlife using established systems
3. To identify and analyze threats such as habitat destruction, urbanization, agricultural expansion, poaching, and human-wildlife conflict.
4. To study standard habitat evaluation processes and various population assessment techniques
5. To learn and apply modern wildlife management techniques, including bio-telemetry and various management practices.
6. To understand and promote eco-tourism and wildlife tourism and study biodiversity formation, conservation of genetic resources, and environmental movements in India.

Course Outcome:

Upon completion of this course, students will be able to:

1. Gain comprehensive understanding of wildlife biology and characteristics of various habitats.
2. Classify plants and animals accurately and understand their ecological roles.
3. Identify and analyze wildlife threats and propose effective conservation strategies.
4. Use various habitat evaluation processes and population assessment techniques effectively.
5. Apply modern wildlife management techniques to monitor and improve wildlife populations and habitats.
6. Understand the principles of sustainable wildlife management and the impact of environmental movements on conservation.

Sr.No.	Name of Unit	Content	Lecture
1	Introduction to Wildlife Biology	<ul style="list-style-type: none"> • Introduction to Wildlife Biology • Definition of Wildlife Biology • Study of Different characteristics of wildlife Habitat in the Biosphere: <ol style="list-style-type: none"> 1. Aquatic Habitat: Marine, Freshwater, and Estuaries. 2. Terrestrial Habitat: Forest, Grassland, Desert, Landscape. 	5
2	Groups of wildlifespecies	<ul style="list-style-type: none"> • Plant Classification: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocot and Dicot) • Animal Classification: <ol style="list-style-type: none"> 1. Arthropods (Insect, Arachnids, Crustaceans, Millipedes, Centipedes), 2. Vertebrates (Mammals, Birds, Fish, 	5

		Reptiles,Amphibians)	
3	Threats to wildlife	Habitat Destruction, Developmental projects, Urbanization, Agriculture expansion, Poaching, Human Wildlife conflict, Deforestation, Exploitation of animals and plants	5
4	Habitat Analysis and Population Assessment Techniques	<ul style="list-style-type: none"> ● Standard Evaluation processes for habitat: HEP & HIS. ● Population Assessment technique (wildlife census) <ol style="list-style-type: none"> 1. Direct count: Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey 2. Indirect count: Pugmark, cameratrap, DNA fingerprinting, Call count, track and sign, pellet count 3. Marking wildlife: Ringing, Tagging, Clipping, Collaring 	5
5	Modern Wildlife Management Techniques	<ul style="list-style-type: none"> ● Bio-telemetry; ● Management practices: Monitoring Wildlife Populations, Habitat Improvement, Hunting Regulations, Artificial Stocking, Controlling or Preventing Disease and Its Spread, Management Funds/Programs, captive breeding and propagation. 	5
6	Sustainable Wildlife management	<ul style="list-style-type: none"> ● Ecotourism / wildlife tourism in forests; ● Reasons for Biodiversity formation, contribution to adaptive evolution, Landraces of crop plants, conservation of genetic resources, highly productive habitats. ● Various Environmental movements in India: Chipko Movement, Appiko movement, Silent valley movement. 	5

References:

1. Principles of Environmental Science - Cunningham and Cunningham
2. Ecology, Environment and Resource Conservation (2006): Singh JS, Singh SP and Gupta SR; Anamaya Publ, New Delhi.
3. Fundamental of Ecology (1971): EP Odum; WB Saunders Company.
4. Plant Diversity Hotspots in India (1997): PK Hajra and V. Mudgal; Botanical Survey of India
5. Environmental Management (2005): Bala Krishnamoorthy; Prentice-Hall of India Pvt. Ltd., New Delhi.

F.Y.B.Sc. Environmental Science (Semester-I)
Course Category: Skill Enhancement Course (SEC)
Course Code – SEC-101-EVS
Course Title: Environmental Geosciences

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

Objective:

1. To understand Earth's internal structure and geological evolution theories, including Continental Drift and Plate Tectonic Theory.
2. To explore soil formation processes, properties, composition, and classification, focusing on the agricultural significance of Indian soils, soil formation process
3. To understand the Earth's atmosphere, its structures, chemical composition, and factors regulating atmospheric temperature.
4. To explore the hydrological cycle and atmospheric pressure, their significance, measurement, and factors affecting weather phenomena.
5. To understand various natural calamities and importance of renewable resources

Outcomes:

Upon completion of this course, students will be able to:

1. Understand the Earth's internal structure, geological evolution theories, and the rock cycle, including rock-forming minerals.
2. Gain knowledge of soil formation, properties, classification, and the agricultural significance of Indian soils.
3. Comprehend the Earth's atmospheric composition, structure, properties, and temperature regulation methods.
4. Understand the hydrological cycle and atmospheric pressure, their processes, and their impact on weather and wind generation.
5. Learn about natural calamities, their causes, management strategies, and the significance of alternative energy resources like wind, geothermal, and solar energy.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Earth & its Structural Components	<ul style="list-style-type: none"> • Internal Structure of Earth • Theories of geological evolution – Wager's • Continental Drift Theory, Plate Tectonic Theory • Types of Rocks – Igneous, Sedimentary, • Metamorphic Rock cycle Rock forming minerals – quartz, feldspar, micas, clay minerals, calcite, dolomite etc. 	06
2	Soil	<ul style="list-style-type: none"> • Formation – weathering processes (types), biomass addition • Physical & chemical properties; composition; • macro & micro plant nutrients • Soil Profile • Soil classification Soils of India – with respect to their agriculture significances. 	06

3	Earth's Atmosphere and Atmospheric temperature	<ul style="list-style-type: none"> • Introduction, general properties • Vertical & horizontal structures • Chemical composition – in each of the vertical layers; past & present Significance • Atmospheric temperature measurement – Instruments; • Methods (maximum, minimum, mean temperature, temperature range); • Factors regulating atmospheric temperature/ temperature controls • Lapse rate; Types – ELR, DALR & WALR 	06
4	Hydrological cycle & Atmospheric pressure	<ul style="list-style-type: none"> • Hydrological cycle – <ul style="list-style-type: none"> i) Introduction & significance ii) Evaporation; Factors affecting the rate of Evaporation iii) Condensation; Factors affecting the rate of forms of condensation – dew, frost, fog & cloud. iv) Precipitation; Factors affecting precipitation; Forms of precipitation – rain, drizzle, snow, hail, sleet etc. • Atmospheric pressure – Introduction; Measurement; Factors affecting the atmospheric pressure, Spatial & Temporal variations, Atmospheric pressure & Generation of winds; Factors affecting winds 	06
5	Natural Calamities & Resources	<ul style="list-style-type: none"> • Natural Calamities – Volcanoes, Earthquakes, Landslides, Cyclones, Floods & Droughts; Causes; Planning & Management to prevent/mitigate their effects; Case studies for each. • Significance of wind, geothermal & solar energy as alternative energy resources 	06

Reference Books -

- 1) Environmental Geology; Valdiya K.S.; Indian Context. Tata McGraw Hill
- 2) Essentials of Climatology; D. S. Lal; Chaitanya Publishing House, Allahabad, 1989.
- 3) Holmes' – Principles of Physical Geology; Edt. by P. McL. D. Duff; ELBS Chapman & Hall Low Priced Edtn; 4th Edtn.
- 4) A Textbook of soil Science; T.D. Biswas & S.K. Mukharjee; Tata McGraw-Hill Education
- 5) Introductory Soil Science; Dilip Kumar Das; Kalyani Publishers; 2nd Edtn.
- 6) Environmental Geology; Kellar E.A. (2011); Prentice Hall, 624 p; 9th Edtn.

F.Y.B.Sc. Environmental Science (Semester-II)**Course Code – EVS-151-T****Course Title: Fundamentals of Environmental Physics and Geochemistry****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****Objective:**

1. To equip students with a fundamental understanding of environmental chemistry principles and their implications for the environment.
2. To explore the chemical interactions within and between different environmental segments like the atmosphere, hydrosphere, and biosphere.
3. To analyze the chemistry of various environmental pollutants and their impact on living organisms.
4. To introduce green chemistry principles and their potential for mitigating environmental issues.
5. To develop analytical skills for environmental sample analysis using various techniques.
6. To gain insights into the role of environmental physics in understanding environmental processes.

Outcomes:

Upon completion of this course, students will be able to:

1. Students will be able to define environmental chemistry and its scope, explaining the interconnectedness of environmental segments.
2. Students will be able to describe the chemical aspects of biogeochemical cycles and their significance in maintaining environmental balance.
3. Students will be able to identify and analyze the chemical reactions occurring in the atmosphere, including those related to major pollutants and climate change.
4. Students will be able to explain the behaviour and impact of heavy metals like Pb, Hg, Cd, and As on human health and the environment.
5. Students will be able to differentiate between various types of surfactants and food additives, evaluating their environmental effects.
6. Students will be able to perform basic environmental analysis using solution concentration measurements, titrimetric methods, and instrumental techniques (pH meter, conductivity meter).
7. Students will be able to explain fundamental concepts of environmental physics, including heat, mass, and energy transfer, radiation types, and the role of Gibbs Energy in environmental processes.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction	<ul style="list-style-type: none"> • Definition and Scope of Environmental Chemistry. • Segments of Environment and various interactive reactions occurring between these segments. • Chemical Aspects of Bio-geo-chemical cycles • Green Chemistry 	16

2	Chemistry of Some Atmospheric Gases	<ul style="list-style-type: none"> • Characteristic of the Chemical Reactions involved in atmosphere. • Pollutants in Atmosphere • Sulphur- Oxides Chemistry. • Nitrogen-Oxides Chemistry • Carbon Oxides Chemistry • Climate Change in Atmosphere 	08
3	Chemistry of some Heavy Metals	<ul style="list-style-type: none"> • Chemistry of Pb, Hg, Cd and As • Physical and chemical properties • Behavior of these heavy metals and their compounds • Human exposure-absorption and influence • Prevention and Control measures of these heavy metals • Case studies related to above heavy metals 	08
4	Chemistry of Surfactants and chemicals in food	<ul style="list-style-type: none"> • Soaps and Detergents, Need, Classification , Characteristic and Composition • Environmental Impacts and Toxicity of Soaps and Detergents • Cationic, Anionic and Non-anionic, modified detergents • Food Additives and Contaminants (Preservatives, Flavoring and coloring agents) • Adulterants –Properties and their effects 	06
5	Environmental Analysis and Environmental Physics	<ul style="list-style-type: none"> • Solution concentration (Normality, Molarity, Molality, ppm, Equivalent weight etc.) • Titrimetric methods. • Basic Principle and working of pH meter and conductivity meter. • Scope of Environmental Physics • Transport and Exchange of Heat • Mass and Energy in environment • Types of radiations in the Environment • Gibbs Energy Equation 	06

Reference Books –

- 1) Environmental Chemistry, A. K. De, New Age International Publishers, 7thEdtn.
- 2) Elements of Environmental Chemistry, H. V. Jadhav, Stosius Incorporated/Advent Books Division, 1992
- 3) Environmental Chemistry, H. Kaur, A Pragati Edtn., 2ndEdtn. (2007)
- 4) Environmental Chemistry, S. K. Banerjee, PHI Learning Pvt. Ltd., 2nd Edtn.
- 5) Forinash K.2010.Foundation of Environmental Physics, Island Press

F.Y.B.Sc. Environmental Science (Semester-II)**Course Code – EVS-152-P****Course Title: Environmental Science Practical II****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Objective:**

1. Develop practical skills in environmental sample collection, preservation, and analysis.
2. Provide hands-on experience with various techniques used for environmental monitoring.
3. Enhance understanding of the theoretical concepts covered in lectures through practical application.

Outcomes:

Upon completion of this course, students will be able to:

1. Demonstrate knowledge of laboratory safety rules and proper handling of laboratory equipment.
2. Collect and preserve water and soil samples using appropriate techniques for accurate analysis.
3. Proficient in measuring basic water quality parameters like pH, electrical conductivity, alkalinity, total hardness, chlorides, TDS, TSS, and TS.
4. Determine soil pH, electrical conductivity, and organic content.
5. Develop skills in identifying common food adulterants.

Sr. No.	Description	Practical Sessions
1.	Laboratory safety rules and introduction to laboratory equipment	01
2.	Collection and preservation of water and soil samples (Field Practical).	02
3.	Determination of pH and Electrical Conductivity of Water samples	01
4.	Determination of pH and Electrical Conductivity of Soil samples	01
5.	Determination of Turbidity of Water	01
6.	Determination of Alkalinity/acidity from water sample	01
7.	Determination of Total Hardness (Ca & Mg) from water.	01
8.	Determination of Chlorides from water.	01
9.	Determination of TDS, TSS & TS from water	01
10.	Determination of detergent concentration in water sample	01
11.	Prepare solutions of different concentrations (normality, molarity, molality, ppm) and perform titrimetric analysis to determine concentrations.	01
12.	Identification of Food adulterants in various food samples	01
13.	Conduct experiments demonstrating the principles of green chemistry: Extraction of plant pigments using water as safe solvent	01
14.	Investigates the insulating properties of air through heat transfer rate measurement.	01
15.	Determination of Organic Content from soil.(Calcium Chloride titration)	01
16.	Study of the working of HVS/RDS machine-(Demonstration).	01
17.	Study of the working of PUC machine-Gas Analyzer (Demonstration).	01
18.	Visit nearest air quality monitoring station and interpret air pollution data	01
19.	Visit a water treatment facility for understanding removal of contaminations from water	01

Note: Conduct any 15 practical's from the above mentioned list

F.Y.B.Sc. Environmental Science (Semester-II)**Option 1****Course Category: Open Elective (OE) / Generic Elective (GE)****Course Code – OE-151-EVS****Course Title: Practical's in Environmental Pollution****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Objectives:**

1. Familiarize students with laboratory safety rules and equipment.
2. Equip students with skills for collecting and preserving water and soil samples. Develop students' ability to analyze water quality parameters like hardness, turbidity, and dissolved oxygen.
3. Provide students with hands-on experience in understanding the impact of environmental factors on water quality.
4. Introduce students to methods for assessing soil properties like pH, electrical conductivity, and permeability.

Outcomes:

Upon completion of this course, students will be able to:

1. Students will be able to follow proper safety protocols in a laboratory setting. (Exp. 1)
2. Students will be able to collect and preserve environmental samples for further analysis. (Exp. 2)
3. Students will be able to measure and analyze various water quality parameters. (Exp. 4, 5, 6)
4. Students will be able to explain the effects of environmental factors on water quality. (Exp. 6, 7)
5. Students will be able to assess soil quality using different techniques. (Exp. 13, 14)

Sr. No.	Description	Practical Sessions
1.	Laboratory safety rules and introduction to laboratory equipment	01
2.	Collection and preservation of water and soil samples (Field Practical).	02
3.	Microscopic Examination of Pond Water/River Water	01
4.	Determination of the hardness of water from different water sources	01
5.	Determination of turbidity of different water sources by using Secchi Disk/Turbidity meter	01
6.	Measure and compare the levels of dissolved oxygen (DO) in hot and cold water samples and understand the impact of temperature	01
7.	Simulate the eutrophication process and monitor the effects on plant growth, algal bloom and oxygen level	01
8.	Visit to the water/sewage treatment and preparation of the report	01
9.	Visit an air quality monitoring station to learn about various air pollutants' equipment and data collection processes.	01
10.	Access online resources or smartphone apps to track the AQI in your area and discuss the factors influencing it.	01
11.	Investigating the Effects of Acid Rain on Different Materials	01
12.	Assess the water usage and identify areas for conservation and efficiency improvements in an educational institution.	01
13.	Determination of pH and Electrical Conductivity of Soil samples	01
14.	Investigate the permeability of different soil types	01
15.	Compare the germination rate and growth of seeds in polluted soil versus non-	01

	polluted soil	
16.	Visit the soil testing laboratory and understand the process and importance of soil testing	01
17.	Collection and classification of solid waste generated in classroom/home.	01
18.	Visit solid waste dumping sites and understand the process of solid waste management	01
19.	Measure noise levels in different environments (classroom, library, playground, street)	01
20.		01

Note: Conduct any 15 practical's form the above mentioned list

F.Y.B.Sc. Environmental Science (Semester-I)**Option 1****Course Category: Open Elective (OE) / Generic Elective (GE)****Course Code – OE-152-EVS****Course Title: Practical's in Wildlife of India****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Objectives:****Course Outcome:**

1. To familiarize students with laboratory safety rules and the use of various laboratory equipment essential for wildlife biology and conservation studies
2. To enable students to prepare wildlife habitat maps and land use/land cover (LULC) maps using topographical sheets and GIS tools to study the distribution and quality of habitats.
3. Train students in field survey techniques and sampling methods for water, plants, and animal populations to assess biodiversity in various habitats.
4. To teach students direct and indirect wildlife population assessment methods, including pellet count surveys, camera trapping, and DNA fingerprinting, to monitor and estimate wildlife populations.

Outcomes:

Upon completion of this course, students will be able to:

1. Demonstrate proficiency in fieldwork techniques for biodiversity surveys and ecological assessments.
2. Exhibit a comprehensive understanding of plant and animal adaptations, enhancing interpretation of ecological interactions.
3. Acquire species identification and classification proficiency, supporting biodiversity research and conservation efforts.
4. Gain insight into biogeographical processes, facilitating interpretation of global biodiversity patterns.
5. Apply knowledge of resource management for informed decision-making and conservation efforts.

Sr.No.	Practical Title	Practical Sessions
1.	Introduction to Laboratory safety rules and introduction to laboratory equipment	1
2.	Prepare wildlife habitat map of India and study its distribution	1
3.	Sample and analyzing water collected from nearby water body to study its diversity.	1
4.	Collect and identifying different plant groups (Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms) in various habitats.	1
5.	Using sweep nets, pitfall traps, and light traps to collect insects and identify them.	1
6.	Prepare list and identifying arthropods and vertebrates in different environments.	1
7.	By visual interpretation technique prepare LULC map of given area (Use Toposheet)	1

8.	Conduct surveys to document the presence of mammals, birds, fish, reptiles, and amphibians from nearby habitat.	1
9.	Apply habitat evaluation procedure (HEP) to assess the quality of specific habitat	1
10.	Using habitat suitability index (HIS) models to determine habitat suitability for various species.	
11.	Demonstrate direct count methods such as block count, transect method and point counts	1
12.	Study and track wildlife populations over time by using available data	1
13.	Study indirect methods like pugmark tracking, camera trapping, DNA fingerprinting etc (Demonstrative)	1
14.	Estimate the population density of herbivores in a specific area using a pellet count survey.	1
15.	Conduct a field survey of different habitats (aquatic and terrestrial) to observe and document the characteristics of each	1
16.	Evaluate the impact of ecotourism on local wildlife and habitats.	1
17.	Visit nearby seed banks and study landraces of crop plants and conservation methods for genetic resources	1
18.	Analyze case studies of human-wildlife conflicts in urban areas.	1
19.	Identify and study the highly productive habitat of the nearby grasslands for its biodiversity value.	1
20.	Prepare and install nest boxes in college premises and study cavity nesting of birds	02
21.	Collect, store, and preserve seeds of native plant species for future restoration projects and conservation efforts.	1
22.	Understand the legal framework and policies related to wildlife conservation in India.	1

Note: conduct any 15 practical's from the above mentioned list

F.Y.B.Sc. Environmental Science (Semester-I)**Course Category: Skill Enhancement Course (SEC)****Course Code – SEC-151-EVS****Course Title: Fundamentals of Environmental Pollution****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****Objectives:**

1. Grasp the basic definitions and classifications of different types of pollution (air, water, soil, noise, thermal, radioactive, and solid waste).
2. Investigate the sources and effects of major pollutants on both biological and non-biological systems, with a focus on real-world case studies.
3. Learn about various control measures and mitigation strategies for different types of pollution, including modern and sustainable practices.
4. Enhance critical thinking and problem-solving skills by analyzing historical case studies and their outcomes, understanding the effectiveness of different pollution control strategies.

Course Outcome:

Upon completion of this course, students will be able to:

1. Clearly define various types of pollution and distinguish between their natural and anthropogenic sources.
2. Identify major air pollutants, their sources, and effects on biological and non-biological systems. Understand the implications of phenomena like the Greenhouse Effect, ozone depletion, smog, acid rain, and global warming.
3. Understand the types, sources, and control measures of water pollution, including eutrophication, bioaccumulation, and biomagnification. Analyze the effects and mitigation of thermal pollution with case studies.
4. Identify the sources and routes of soil pollution. Evaluate the effects on soil quality and biological systems. Explore sustainable agricultural practices and control measures to mitigate soil pollution.
5. Utilize knowledge gained to assess environmental pollution in diverse contexts. Propose effective solutions and strategies based on case study analysis, aiming for sustainable environmental management.

Unit No.	Name of the Unit	Contents	No. of Lectures
1	Introduction	<ul style="list-style-type: none"> • Pollution – Definition; Types –Air, Water Soil, Noise, Thermal, Radioactive and Solid waste, Natural and Anthropogenic 	06
2	Air and Radioactive Pollution	<ul style="list-style-type: none"> • Definition; Major air pollutants and their sources; Effects – On Biological system – Animals, humans & plants, On Non, Biological systems – material; physical environment • Green House Effect, Ozone depletion, Smog, Acid Rain, Global warming 	06

		<ul style="list-style-type: none"> Case studies – London smog; Los Angeles smog; Taj-Mahal, Asian Brown Cloud Radioactive pollution- Definition, Sources and Effects 	
3	Water and Thermal pollution	<ul style="list-style-type: none"> Definition, Types (Ground, Surface and Marine) Sources, Effects & control measures Detergent – Eutrophication Pesticide – Bioaccumulation, bio magnifications Heavy metal pollution – Pb, Hg, Cd & As Case studies – Itai- Itai & Minamata (Japan); Arsenic poisoning (West Bengal) etc. Definition, Sources ,Effects and Control measures of Thermal pollution, Case studies 	06
4	Soil pollution	<ul style="list-style-type: none"> Definition; Sources/ routes of contamination Effects – On soil quality/ productivity – Acidification, Alkalinization, Salinization, Sodification, Desertification, Heavy metal deposition etc. On Biological system – on soil microorganisms, on plants. Control measures/ Alternatives – <ul style="list-style-type: none"> i) Biofertilizers & biological pest management; ii) Organic farming & other agricultural interventions; iii) Appropriate irrigation & drainage techniques; iv) Lime & gypsum application. Case studies – Declining soil productivity in the Punjab & v) Haryana; desertification in India, Western Maharashtra 	06
5	Noise and Radiation, Thermal Pollution	<p>Noise Pollution: Definition, Historical context, Sources, physical and psychological impacts, noise measurement, noise control measures: sound barriers, insulations, urban planning, zoning law and traffic management, PPE Kit, etc.,</p> <p>Radiation Pollution: Definition, Historical context, types of radiation (ionizing and non-ionizing), sources (Natural, anthropogenic), health and environmental impacts (acute, chronic, etc.), case study (Chornobyl, Fukushima)</p> <p>Thermal pollution: Definition, Historical context, Sources, effects, mitigation strategies: cooling tower, cooling pond, spray tower,</p>	06

Reference Books -

- 1) Air Pollution- M. N. Rao & H.V.N. Rao; Tata McGraw Hill, New Delhi, 1989.
- 2) "Environment Pollution Control and Environmental Engg." C. S. Rao, Tata McGraw Hill, New Delhi, 1994.
- 3) Soil pollution & Soil Organism - P.V. Mishra
- 4) Water Pollution- A.K. Tripathy & S.N. Pandey; A. P. H. Publishing Corporation

- 5) Environmental Air pollution & it's control—G.R. Chatwal; Anmol Publications, New Delhi, 1989
- 6) Environmental Chemistry; A. K. De; New Age International Publishers; 6thEdtn.
- 7) Understanding Environment; Edt by Kiran B. Chhokar, MamataPandya, Meena Raghunathan; Centre for Environment Education; Sage Publication.
- 8) Perspective in Environmental Studies; Kaushik & Kaushik; New Age International Pvt. Ltd Publishers
- 9) Environmental Science; S. C. Santra; New Central Book Agency (P) Ltd.; 2ndEdtn.
- 10) Water Pollution, P.K. Goel, New Age International, 2006 Revised Edtn