Curriculum Book

and

Assessment and Evaluation Scheme

Based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

in

Master of Science Environmental Science

M.Sc. Environmental Science

2 Year Degree Program

Revised as on 01 August 2023
Applicable w.e.f. Academic Session 2023-24

AKS University

Satna- 485001, Madhya Pradesh, India

Faculty of Life Science & Technology

Department of Environmental Science

A K S University

Faculty of Life Science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

CONTENTS

****

Head of Department
Environmental Science
AKS University, Satna (M.P.)

Professor B.A. Chopade
Vice-Chancellor
AKS University
Satna, 485001 (M.P.)

Dean
Faculty of Life Science & Technology
AKS University
Satna (M.P.) 485001

Forwarding

I am pleased to forward the proposed curriculum for the 2-year M.Sc. Environmental Science program, which has been designed in alignment with the Outcome-Based Education (OBE) framework and the Choice Based Credit System (CBCS) as per the guidelines of the National Education Policy (NEP) 2020.

This curriculum aims to provide students with a comprehensive understanding of environmental science, emphasizing the acquisition of practical skills and knowledge essential for addressing contemporary environmental challenges. The OBE framework ensures that the program outcomes are clearly defined and measurable, facilitating continuous improvement in teaching and learning processes. The CBCS structure allows flexibility and student-centric learning, enabling students to choose courses according to their interests and career goals.

We believe that this revised curriculum will significantly enhance the academic and professional development of our students, preparing them to contribute effectively to the field of environmental science.

01 August 2023

Er. Anant Kumar Soni
Pro Chancellor & Chairman
AKS University, Satna (M.P.)

From the Desk of Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, with the aim of enhancing the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships.

In alignment with the National Education Policy (NEP) 2020, AKS University, Satna, is proud to announce the upgraded curriculum for the M.Sc. Environmental Science program. This comprehensive revision integrates the Outcome-Based Education (OBE) framework and the Choice Based Credit System (CBCS), ensuring our students receive a modern, flexible, and student-centric education.

Our curriculum is meticulously mapped to ensure alignment with the PEOs, POs, and PSOs. The OBE framework focuses on achieving specific outcomes through well-defined objectives, ensuring students attain the desired competencies and skills. Continuous assessment and feedback mechanisms are integrated to monitor and enhance learning outcomes.

The upgraded curriculum addresses the growing environmental challenges and equips students with the necessary skills to contribute effectively to sustainable development. The M.Sc. Environmental Science program is designed to produce graduates who are knowledgeable and capable of implementing innovative solutions to environmental issues. The integration of OBE and CBCS ensures that our students receive a balanced education, combining theoretical knowledge with practical application.

At AKS University, we are committed to providing our students with the best possible education and preparing them for successful careers. The revised M.Sc. Environmental Science curriculum is a testament to our dedication to academic excellence and our responsiveness to global environmental challenges.

We warmly invite input and suggestions from industry experts and technocrats and Alumni students to enhance the curriculum and make it more student-centric. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

We invite you to join us on this journey towards a sustainable future.

01 August 2023

Professor B. A. Chopade
Vice- Chancellor
AKS University, Satna (M.P.)

PREFACE

The Department of Environmental Science at AKS University, Satna, is at the forefront of fostering a deeper understanding of environmental issues and promoting sustainable practices. Our department is dedicated to providing students with a comprehensive education that blends theoretical knowledge with practical skills. We aim to prepare our students to become leaders in environmental science, capable of addressing the complex environmental challenges facing our world today.

As part of our ongoing commitment to excellence in education, we have undertaken a significant revision of our M.Sc. Environmental Science curriculum. This revision is aligned with the National Education Policy (NEP) 2020 and incorporates the Outcome-Based Education (OBE) framework and the Choice Based Credit System (CBCS). These changes are designed to provide a more flexible, student-centered learning experience that better prepares our graduates for their future careers.

This curriculum update is crucial for equipping our students with the necessary skills and knowledge to excel in their professional lives and contribute meaningfully to environmental sustainability. By emphasizing practical application and interdisciplinary learning, we are confident that our graduates will be well-prepared to meet the dynamic challenges of the environmental sector.

We believe that this revamped curriculum will significantly enhance the educational experience of our students, preparing them to meet the challenges of the ever-changing environmental landscape with competence and confidence. We are dedicated to fostering an environment that supports innovation, critical thinking, and a commitment to sustainability.

We hold the belief that this dynamic curriculum will undoubtedly enhance independent thinking, skills, and overall employability of the students.

I would like to extend my sincere gratitude to our dedicated faculty, staff, and students for their hard work and collaboration in bringing this revised curriculum to fruition. Together, we are setting a new standard for environmental science education.

01 August 2023

Professor (Dr.) G.P. Richhariya
Dean
Faculty of Life Sciences and Technology
AKS University, Satna

Introduction:

The Environmental Science Department at AKS University, Satna, is dedicated to advancing environmental knowledge through education, research, and community engagement. Offering a range of Ph.D. Environmental Science, M.Sc. Environmental Science. After few years, the department started offering PG Diploma in Safety, Health & Environment (PGDSHE), PG diploma in Environment Pollution Management (PGDEPM). the Department equips students with the skills needed to tackle environmental challenges. With state-of-the-art laboratories and research facilities, The Department focuses on areas such as environmental chemistry, ecology, conservation, biotechnology, and geoinformatics. The department is well equipped with modern facilities for pursuing research in various fields of environmental science. The highly qualified faculty, active research projects, and collaborative efforts with academic and industry partners enhance its educational and research initiatives, making it a leading institution for environmental studies in the region.

Vision of the Department

The Department of Environmental Science committed to develop as a cutting-edge advance center for interdisciplinary education and research. The department program will provide transformative and novel research on challenging environmental issues through education, collaboration and engagement.

Mission of the Department

M1: Human resource development to tackle environmental challenges and to achieve sustainability.

M2: Promote cost effective technologies for agriculture and industries for nation building andquality teaching and knowledge on current environmental issues.

M3: Impart environmental awareness and education for healthy, pollution free and habitable environment.

Program Educational Objectives

For M.Sc. in Environmental Science typically outline the career and professional accomplishments that students of the program are expected to achieve within a few years after completing their degree.

PEO1: Professional Practice: Students will be equipped with the knowledge and skills necessary to engage in professional practice in the field of environmental science, including conducting research, analysis, and interpretation of environmental data.

PEO2: Interdisciplinary Approach: Students will be able to integrate knowledge and methodologies from various disciplines such as biology, chemistry, geology, and social sciences to address multifaceted environmental issues comprehensively.

PEO3: Research and Innovation: Students will demonstrate proficiency in conducting original research, utilizing appropriate research methods, technologies, and tools to contribute new insights and advancements to the field of environmental science.

PEO4: Sustainability Advocacy: Students will contribute to the promotion of sustainability principles and practices in their professional endeavors, advocating for environmentally responsible policies, technologies, and practices.

PEO5: Lifelong Learning and Professional Development: Students will recognize the importance of lifelong learning and pursue opportunities for professional development to stay updated with advancements in environmental science, technology, and policy, enhancing their effectiveness as environmental professionals over their careers.

Program Outcomes

PO1: Environmental Knowledge: Describe the diverse concepts and methods of environmental sciences and their application in various aspects of environmental issues.

PO2: Planning abilities: Demonstrate effective planning to deal with different problems associated with environmental issues such as solid waste management, Energy auditing and Impact assessment of various developmental activities.

PO3: Problem analysis: Formulate mitigation measures for various environmental issues such as waste management and pollution, food and agriculture, energy, climate change, population, resource management and loss of biodiversity.

PO4: Design/development of solution for problems: The research skills strengthen them to formulate hypothesis, identification of environmental problems and develop solution for the betterment of the environment.

PO5: Modern tool usage: Apply various tools commonly used in field research, particularly in the study of air water and soil quality along with spatial analysis software and tools such as GIS and GPS technology.

PO6: Leadership skills: Use their knowledge of EIA and Environmental laws to critically think about their roles and identities as citizens, consumers and environmental actors in an interconnected world.

PO7: Professional Identity: Demonstrate the ability to interpret the consequences of developing projects and consult various environmental agencies to a focused solution.

PO8: Environmental Ethics: Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

PO9: Communication: Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, along with written and oral communication needed to conduct high-level work as interdisciplinary scholars.

PO10: The Environment and society: Describe various problems associated with sustainable development of project and its impact on society.

PO11: Environment and sustainability: Formulate an action plan for sustainable alternatives that integrate science, humanist, and social perspectives.

PO12: Life- long learning: Prepare them for meaningful careers and higher education in fields related to environmental science and beyond.

Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) provide more detailed and specific outcomes that students are expected to achieve upon completing an M.Sc. in Environmental Science program.

PSO 1: Proficiency in Environmental Analysis and Assessment:

Students will demonstrate proficiency in conducting environmental assessments, including data collection, analysis, interpretation, and reporting using appropriate scientific methods and tools.
PSO 2: Application of Multidisciplinary Approaches:

Students will be able to apply knowledge and methodologies from multiple disciplines, including biology, chemistry, geology, and social sciences, to address complex environmental problems and develop sustainable solutions.

PSO 3: Critical Thinking and Problem-Solving Skills:

Students will develop critical thinking skills necessary to evaluate environmental issues, identify root causes, and develop innovative and sustainable solutions to address environmental challenges effectively.

PSO 4: Professional Ethics and Social Responsibility:

Students will uphold ethical standards in their professional practice, demonstrating a commitment to integrity, social responsibility, and environmental stewardship in all aspects of their work.

Consistency / Mappings of PEOs with Mission of the Department

PEO	M 1	M 2	M 3
PEO 1	H	M	H
PEO 2	H	H	H
PEO 3	H	M	H
PEO 4	M	H	H
PEO 5	H	M	H

Correlation Indices: H=High, M=Medium, L=Low, N=Nil

GENERAL COURSE STRUCTURE & THEME

Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits:

In the light of the fact that a typical Model Two-year Post Graduate degree program inEnvironmental Science has about 92 credits, the total number of credits proposed for the Two-year Master of Science in Environmental Science is kept as 92 considering NEP-20 and NAAC guidelines.

A K S University

Faculty of Life Science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

General Course Structure and Credit Distribution

Curriculum of Master of Environmental Science

Semester –I		**Semester – II**	
Course Title	Credit	Course Title	Credit
Fundamental of Environmental Science	3:1:0 = 4	Energy & Environment	3:1:0 = 4
Natural Resources & Conservation	3:1:0 = 4	Waste Management	3:1:0 = 4
Environmental Pollution &Control Technology	3:1:0 = 4	Environmental Instruments & Analytical Techniques	3:1:0 = 4
Environmental Chemistry	3:1:0 = 4	Remote Sensing & Geoinformatics	3:1:0 = 4
Practical Lab-I	0:0:6= 3	Practical Lab-I	0:0:6= 3
Practical Lab-II	0:0:6= 3	Practical Lab-II	0:0:6= 3
Seminar/workshop	2	Industrial visit/Field work/Educational tour	2
Total Credit	**24**	**Total Credit**	**24**
Semester –III		**Semester – IV**	
Environmental Microbiology & Biotechnology	3:1:0 = 4	Industrial Safety & Hygiene	3:1:0 = 4
Research Methods & Paper Writing	3:1:0 = 4	**Elective paper Group D Choose any one** i. EIA & EMS ii. Environmental Economics	3:1:0 = 4
Departmental Elective Course Choose any one i. National Issues & Disaster Management ii. Environmental Toxicology	3:1:0 = 4	Major Project/Dissertation viva	12
Departmental Elective Course Choose any one i. Environmental Law, Policies & Ethics Environmental statistics and modeling	3:1:0 = 4		
Practical Lab-I	0:0:6= 3		
Practical Lab-II	0:0:6= 3		
Field work	2		
Total	**24**	**Total**	**20**

Major Projects: major projects are compulsory for all III[rd] and IV[th] Semester students in a particular topic of Environment.

Course code and definition:

L	=	Lecture
T	=	Tutorial
PC	=	Practical Credit
ESC	=	Engineering Science Courses
P_fCC	=	Professional core courses
PEC	=	Program elective course
PLC	=	Program Laboratory course

Course level coding scheme:

Three-digit number (odd numbers are for the odd semester courses and even numbers are for evensemester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g. 101, 102 etc. for first year. 201, 202 Etc. for second year. 301, 302 for third year.401. 402 for Fourth year.

Induction Program

Induction Program Induction program for students to be offered right at the start of the first year. Itis mandatory. AKS University has designed an induction program for 1[st] year student, details are below:

i. Physical activity
ii. Creative Arts
iii. Universal Human Values
iv. Literary
v. Proficiency Modules
vi. Lectures by Eminent speakers
vii. Visits to local Areas
viii. Familiarization to Dept./Branch & Innovations Mandatory Visits/ Workshop/Expert

Lectures:

i. It is mandatory to arrange one industrial visit every semester for the students.

ii. It is mandatory to conduct a One-week workshop during the winter break after third semester on professional/ industry/ entrepreneurial orientation.

iii. It is mandatory to organize at least one expert lecture per semester foreach branch by expert resource per sons from industry.

Evaluation Scheme:

1. **For Theory Courses:**
   i. The weightage of Internal assessment is 50% and
   ii. End Semester Exam is 50% The student has to obtain at least 40% marks individually both internal assessment and end semester exams to pass.
2. **For Practical Courses:**
   i. The weightage of Internal assessment is 50% and
   ii. End Semester Exam is 50% The student has to obtain at least 40% marks individually both internal assessment and end semester exams to pass.
3. **For Field work / Projects / Seminar etc.:**

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

4. **For Project dissertation.**

i. The weightage of Major project is 100% The student has to obtain at least 40% marks individually project to pass.

Semester wise Course Structure

Semester wise Brief of total Credits and Teaching Hours

Semester	L	T	P	Total Hour	Total Credit
Semester –I	12	4	12	28X15=420	24
Semester –II	12	4	12	28X15=420	24
Semester –III	12	4	12	28X15=420	24
Semester – IV	6	2	-	8X15=120	20
Total	**42**	**14**	**36**	**1380**	**92**

Details of Semester Wise Course structure

Structure Semester – I

S.N	Subject Code	Category	Subject	Periods			Creditt
				L	T	P	
1	79EV101	PCC	Fundamental of Environmental Science	3	1	-	4
2	79EV102	PCC	Natural Resources & Conservation	3	1	-	4
3	79EV103	PCC	Environmental Pollution & Control Technology	3	1	-	4
4	79EV104	PCC	Environmental Chemistry	3	1	-	4
5	79EV151	PLC	Practical Lab-I	-	-	6	3
6	79EV152	PLC	Practical Lab-II	-	-	6	3
7	79EV153	P_fCC	Seminar/workshop				2
Total				**12**	**4**	**12**	**24**

II Semester

S. No.	Subject Code	Category	Subject	Periods			Credit
				L	T	P	
1	79EV201	PCC	Energy& Environment	3	1	-	4
2	79EV202	PCC	Waste Management	3	1	-	4
3	79EV203	PCC	Environmental Instruments &Analytical Techniques	3	1	-	4
4	79EV204	PCC	Remote Sensing& Geoinformatics	3	1	-	4
5	79EV251	PLC	Practical Lab-I	-	-	6	3
6	79EV252	PLC	Practical Lab-II	-	-	6	3
7	79EV253	P_fCC	Industrial visit/ Field work/ Educational tour (max.7days)				2
			Total	**12**	**4**	**12**	**24**

III Semester

S. No.	Subject Code	Category	Subject	Periods			Credit
				L	T	P	
1	79EV301	PCC	Environmental Microbiology &Biotechnology	3	1	-	4
2	79EV302	PCC	Research Methods & Paper Writing	3	1	-	4
3	**Departmental Elective Course Choose anyone**			3	1	-	4
	79EV303A	PEC	i. National Issues & Disaster Management				
	79EV303B		ii.Environmental Toxicology				
4	**Departmental Elective Course Choose anyone**			3	1	-	4
	79EV304A	PEC	i.Environmental Law, Policies & Ethics				
	79EV304B		ii. Environmental statistics and modeling				
5	79EV351	PLC	Practical Lab-I	-	-	6	3
6	79EV352	PLC	Practical Lab-II	-	-	6	3
7	79EV353	P_fCC	Fieldwork				2
			Total	**12**	**4**	**12**	**24**

IV Semester

S. No.	Subject Code	Category	Subject	Periods			Credit
				L	T	P	
1	79EV401	P_fCC	Industrial Safety & Hygiene	3	1	-	4
	Elective paper Group D Choose anyone						
2	79EV402A 79EV402B	PEC	i. EIA&EMS ii. Environmental Economics	3	1	-	4
3	79EV451	PCC	Major Project/Dissertation viva				12
			Total	**6**	**2**		**20**

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-I

Course Code: 79EV101

Course Title: Fundamental of Environmental Science

Pre- requisite: Student should have basic knowledge of Ecosystem & Biodiversity.

Rationale: The students studying Environmental Science should possess foundational understanding about environment. It helps students understand and explore the interconnected nature of services the environment provides.

Course Outcomes:

79EV 101.1: Know about goal of environmental education and environmental regulatory authority of India.
79EV101.2: Describe the interaction of organisms with their environment.

79EV101.3: Identify the various threats & conservation strategy of biodiversity.

79EV101.4: Explain the structure & functions of ecosystems.
79EV101.5: Learn about population and community ecology.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV101	Fundamental of Environmental Science	3+1	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 2 marks each	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV101	Fundamental of Environmental Science	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV101.1: Know about goal of environmental education and environmental regulatory authority of India.

Approximate Hours

Item	AppX Hrs.
Cl	10
LI	0
SW	3
SL	2
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Understand the components of the environment. **SO1.2** Learn Scopes of Environmental Science **SO1.3** Describe the Goal of Environmental awareness and education. **SO1.4** Know the Environmental movements in India. **SO1.**5 know about the environment regulatory organizations in India.		**Unit-1 Introduction to Environment & Environmental Science** **1.1** Environment- Definition & Components **1.2 Biotic components of environment** **1.3 Abiotic components of environment** **1.4 Tutorial 1** **1.5** Definition & Scopes of environmental science **1.6** Multidisciplinary nature of Environmental Science **1.7** Tutorial 2 **1.8** Goal of Environmental awareness and education. **1.9** Environmentalists and Environmental movements in India Brief introduction to environment regulatory organizations in India- MoEFCC, CPCB, SPCB. 1.10 Tutorial 3	1. What is biotic and abiotic components of the environment? 2. What is interaction?

SW-1 Suggested Sessional Work (SW):

a. Assignments:

I. environment regulatory organizations in India- MoEFCC, CPCB, SPCB.

II. Write note on the environmentalists of India.

III. Write about the environmental movements of India.

IV. What is the goal of Environmental awareness and education.

b. Mini Project:

i. Structure of atmosphere.

c. Other Activities (Specify):

Flow diagram of components of environment.

79EV 101.2: Describe the interaction of organisms with their environment.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	2
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Understand ecology. **SO2.2** Learn about the application of ecology. **SO2.3** Know limiting factors. **SO2.4** Understand abiotic factors of environment. **SO2.**5 Learn about the biotic factors of the environment.		Unit-2 **Ecology** 2.1 Definition and scopes of ecology 2.2 Branches of Ecology 2.2 Application and significance of ecology 2.3 Tutorial 1 2.4 Ecological landmark 2.5 Environmental factors: abiotic factor 2.6 Environmental factors: biotic factor 2.7 Limiting factors 2.8 Tutorial 2 2.9 Leibig's & Shelford's law 2.10 Ecological indicators 2.11 Ecological Relationship: Intraspecific relationship 2.12 Ecological Relationship: Interspecific relationship	i.Environmental factors: Abiotic factors ii. Environmental factors: biotic factors

		2.13 Tutorial 3	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Describe Leibig's & Shelford's law.
ii. Ecological Relationship: Intraspecific & Interspecific.
iii. Describe limiting factors.
iv. Mention the branches of ecology.
v. Write the definition and scopes of ecology.

b. Mini Project:

Application and significance of ecology

c. Other Activities (Specify):

Types of ecology

79EV101.3: Explain the structure & functions of ecosystems.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Know the Concept and definition of ecosystem **SO3.2** Understand types of ecosystems **SO3.3** Describe structure of ecosystem **SO3.4** Understand function of ecosystem **SO3.**5 Describe energy flow in the ecosystem.		**Unit-3: Ecosystem** 3.1 Concept and definition of ecosystem 3.2 Types of ecosystems 3.3 Structure of ecosystem, 3.4 Tutorial 1 3.5 Functions of ecosystem, 3.6 Energy flow in the ecosystem 3.7 Food chain & food web 3.8 Tutorial 2 3.9 Ecological pyramids 3.10Biomes 3.11Factors affecting ecosystem 3.12Tutorial 3	i. Types of food chain. ii. Law of 10%.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Structure of ecosystem.
ii. Food chain & food web
iii. Ecological pyramids.
iv. Energy flow in the ecosystem.

b. Mini Project:

Various types of ecosystems.

c. Other Activities (Specify):

Factors affecting ecosystem

79EV 101.4: Identify the various threats & conservation strategy of biodiversity.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understanding the types of biodiversity **SO4.2** Identify biodiversity hotspot **SO4.3** Know threats to biodiversity **SO4.4** Prepare Biodiversity conservation strategies **SO4.**5 Understand biogeographical classification of India		**Unit-4:** Biodiversity and its conservation. 4.1 Definition and types of biodiversity 4.2 Hotspot of biodiversity 4.3 values of biodiversity 4.4 Tutorial 1 4.5 threats to biodiversity 4.6 Red data book 4.7 ERT and endemic species of India 4.8 Tutorial 2 4.9 Biodiversity conservation strategies 4.10 Biogeographical classification of India 4.11 Tutorial 3	i. Importance of biodiversity ii. Features of ERT species

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Write ERT and endemic species of India.
ii. Describe briefly the conservation of biodiversity.
iii. Write definition and types of ecosystems.
iv. Discuss threats to biodiversity**.**

b. Mini Project:

i. Visit to nearest park or forest & observe the biodiversity.

d. Other Activities (Specify):

Power Point Presentation of biogeographical area of India.

79EV101. 5: Learn about population and community ecology.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	3
SL	2
Total	19

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 Understand definition of population. **SO5.2** Know the population characteristics **SO5.3** Learn biotic potential and environmental resistances **SO5.4 know** Factors of population regulation **SO5.**5 Learn Community– analytical and synthetic characters.		**Unit 5: Population & Community** 5.1 Definition of population 5.2 Population characteristics 5.3 Population regulation 5.4 Tutorial 1 5.5 Biotic potential and environmental resistances 5.6 r and k selections 5.7 Factors of population regulation 5.8 Density dependent and density independent 5.9 Tutorial 2 5.10 Genecology 5.11 Ecads, invasive species 5.12 Ecotypes, Ecospecies, Niche, Keystone species 5.13 Community– analytical and synthetic characters. 5.14 Tutorial 3	1.Effect of population on environment. 2. what is community.

a. Assignments:

i. Definition of population, population characteristics, population regulation.
ii. Describe r & k selection.
iii. Describe Ecotypes, Ecospecies, Niche, Keystone species

b. Mini Project:

density dependent and density independent

c. Other Activities (Specify):

Factors of population regulation

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+Ll+SW+Sl)
79EV 101.1: Know about goal of environmental education and environmental regulatory authority of India.	10	-	3	2	15
79EV 101.2: Describe the interaction of organisms with their environment.	13	-	3	2	18
79EV 101.3: Identify the various threats & conservation strategy of biodiversity.	12	-	3	2	17
79EV 101.4**:** Explain the structure & functions of ecosystems.	11	-	3	2	16
79EV 101.5: Learn about population and community ecology. .	14	-	3	2	19
Total Hours	60	0	15	10	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO-1	**Introduction to Environment & Environmental Science**	03	01	01	05
CO-2	**Ecology**	02	06	02	10
CO-3	**Ecosystem**	03	07	05	15
CO-4	**Biodiversity and its conservation**	-	10	05	15
CO-5	**Population & Community**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Introduction to Environmental Science	Anjaneyulu, Y.	BSP Books Pvt. Ltd.Hyderabad	2009
2	Ecology	Arora.M.P	Himalaya Publication	2016
3	Ecology & Environment	Sharma.P.D	Rastogi Publication, Meerut	2017
4	An Introduction to Ecology and Environmental Science	Prabu	Abhijeet Publication Delhi	2009
5	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV101
Course Title: Fundamental of Environmental Science

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for problems	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Know about goal of environmental education and environmental regulatory authority of India.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Describe the interaction of organisms with their environment.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**
CO3: Identify the various threats & conservation strategy of biodiversity.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

CO 4: Explain the structure & functions of ecosystems.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO 5: Learn about population and community ecology.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Know about goal of environmental education and environmental regulatory authority of India.	SO1.1S O1.2S O1.3S O1.4 SO1.5		Unit-1 **Introduction to Environment & Environmental Science** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Describe the interaction of organisms with their environment.	SO2.1S O2.2S O2.3 SO2.4 SO2.5		Unit-2 **Ecology** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.12,2.13	As mentioned in

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Identify the various threats & conservation strategy of biodiversity.	SO3.1S O3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3.3, 3.4,3.5,3.6, 3.7,3.8	Unit-3: **Ecosystem** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12	page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain the structure & functions of ecosystems.	SO4.1S O4.2S O4.3S O4.4 SO4.5	4.1,4.2,4.3,4.4,4.5,4.6, 4.7,4.8	Unit-4: Biodiversity and its conservation. 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Learn about population and community ecology.	SO5.1S O5.2S O5.3S O5.4 SO5.5	5.1,5.2,5.3,5.4,5.5,5.6, 5.7	Unit 5: **Population & Community** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8,5.9,5.10,5.11,5.12,5.13,5. 14	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Course Code:	79EV102
Course Title:	Natural Resources & Conservation
Pre- requisite:	Student should have basic knowledge about natural resources.
Rationale:	The students studying Environmental Science should possess foundational understanding about natural resources and their conservation. Objectives of natural resources &conservation are to protect and preserve the flora and fauna to maintain the balance in the ecosystem.

Course Outcomes:

79EV 102.1: Identify various natural resources.

79EV102.2: Gain knowledge conservation strategies of natural resources.

79EV102.3: Analyse impact of overexploitation of natural resources.

79EV102.4: Describe concept of sustainable development.

79EV101.5: Get information about mineral resources.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV102	Natural Resources & Conservation	3+1	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+		
PCC	79EV102	Natural Resources & Conservation	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV102.1: Identify various natural resources.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Learn the definition of natural resources. **SO1.2** Know the resource of India. **SO1.3**Learn about Carbon credit and carbon foot print. **SO1.4** Understand sustainable development. **SO1.**5 Describe strategies of resource conservation.		**Unit-1 Introduction** **1.1** Definition & Types of Natural Resources. **1.2** resources of India. **1.3** Carbon credit**.** **1.4 Tutorial 1** **1.5** carbon foot print **1.6** concept of sustainable development. **1.7** Goals of sustainable development. **1.8 Tutorial 2** **1.9** Issues related with sustainable development 1.10 Role of an individual in conservation of natural resources. 1.11 Tutorial 3	**1.** Types of natural resources. **2.** Role of an individual in conservation of water resources.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Role of an individual in conservation of natural resources.
ii. Mention issues related with sustainable development**.**
iii. Define natural resources and write its classification.
iv. Describe resources of India**.**

b. Mini Project:

i. Goals of sustainable development.

c. Other Activities (Specify):

Presentation on carbon credit and carbon foot print.

79EV 102.2: Gain knowledge conservation strategies of natural resources.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	3
SL	2
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Learn about forest products. **SO2.2** Know about Forest scenario. **SO2.3** Know the importance of forest. **SO2.4** Understand deforestation. **SO2.**5 Learn conservation of forest.		Unit-2 **Forest Resources** 2.1 Products of forest. 2.2 Forest scenario of India 2.3 Importance of forest 2.4 Environmental importance 2.5 Ecological importance 2.6 Forest covers in India 2.7 Deforestation 2.8 Causes of Deforestation 2.9 consequences of deforestation 2.10 Afforestation 2.11 Social forestry 2.12 Forest conservation 2.13 Tutorial 1	i.Forest Products ii. Afforestation

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Importance of forest
ii. Social forestry
iii. Write the consequences of deforestation.

iv. Mention forest products.

b. Mini Project:

Strategies for forest conservation

c. Other Activities (Specify):

Forest visit

79EV102.3: Analyse impact of overexploitation of natural resources.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	00
SW	3
SL	2
Total	19

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Know the forms of water. **SO3.2** Understand water distribution. **SO3.3** Learn water conservation. **SO3.4** Understand water harvesting **SO3.**5 Describe water shade management.		**Unit-3: Water Resources** 3.1 Forms of water 3.2 Earth's water distribution 3.3 Global water balance 3.4 Tutorial 1 3.5 Resources of ocean 3.6 Groundwater provinces of India 3.7 Water demand 3.8 Impact of dam on water resource 3.9 Tutorial 2 3.10 Impact of mining on water resources. 3.11 Water Conservation Strategies in India 3.12 Rain Water Harvesting 3.13 Water shade management 3.14 Tutorial 3	i. Forms of Water ii. Water distribution on earth.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Collect data of water distribution on earth.
ii. Impact of dams and mining on water resources.
iii. Water Conservation Strategies in India.
iv. Impact of dam on water resource

b. Mini Project:

Various modal of water harvesting.

c. Other Activities (Specify):

Collect the list of water resource nearby you.

79EV 102.4: Describe concept of sustainable development.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	09
SW	3
SL	2
Total	25

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Learn about land resource. **SO4.2** Know soil erosion and its types. **SO4.3** Describe soil conservation. **SO4.4** Prepare soil		**Unit-4:** Land & Food Resources 4.1 Land as a resource 4.2 Land degradation 4.3 Tutorial 1 4.4 Soil erosion-types & causes 4.5 Soil conservation strategies. 4.6 Types of food	i. Causes of land degradation ii. What is modern agriculture.

conservation strategies. **SO4.**5 Understand modern agriculture.		resources 4.7 Tutorial 2 4.8 World food problems 4.9 Impacts of climate change on food production 4.10 Impact of modern agriculture & pesticides on agriculture. 4.11 Tutorial 3	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Write about different crops of India.
ii. Describe briefly the methods of soil conservation.
iii. Mention the impacts of climate change on food production.
iv. Discuss the world food problems.

b. Mini Project:

i. Write a report on effects of modern agriculture.

c. Other Activities (Specify):

Power Point Presentation on soil erosion

79EV 102.5: Get information about mineral resources.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 Learn about Minerals. **SO5.2** Describe the types of minerals. **SO5.3** Describe resources of oceans. **SO5.4** Understand effects of mineral extraction. **SO5.**5 Learn conservation of minerals.		**Unit-5:** Mineral Resources 5.1 Mineral resources in India 5.2 Types of mineral resources 5.3 Tutorial 1 5.4 Oceans as new areas for exploration of minerals resources 5.5 Environmental impact of mineral extraction. 5.6 Processing of minerals - 1 5.7 Processing of minerals - 2 5.8 Tutorial 2 5.9 Smelting of minerals. 5.10 Conservation of Mineral resources 5.11 Tutorial 3	i. What are minerals? ii. Resources of oceans.

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

i. Definition of minerals, their types & effects of mineral extraction.
ii. Describe the processing of minerals.

b. Mini Project:

Conservation of minerals

c. Other Activities (Specify):

Oceans as new areas for exploration of minerals resources

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV102.1: Identify various natural resources.	11	0	3	2	16
79EV102.2: Gain knowledge conservation strategies of natural resources.	13	0	3	2	18
79EV102.3: Analyse impact of overexploitation of natural resources.	14	0	3	2	19
79EV102.4: Describe concept of sustainable development.	11	0	3	2	16
79EV102.5: Get information about mineral resources.	11	0	3	2	16
Total Hours	60	0	15	10	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO-1	**Introduction**	03	01	01	05

CO-2	**Forest Resources**	02	06	02	10
CO-3	**Water Resources**	03	07	05	15
CO-4	**Land & Food Resources**	-	10	05	15
CO-5	**Mineral Resources**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Environmental Ecology	Gurudeep Raj, P.R. Trivedi	Akashdeep publishing house.	1997
2	Forests in India	V.P. Agrawal	Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi,	1968
3	An Introduction to Environmental Management	Dr. Anand S.Bal	Himalaya Publishing House	2005
4	A Tex Book of environmental	Purohit, Shammi, Agarwal	Student edition, Jodhpur	2012

	Sciences			
5	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV102

Course Title: Natural Resources & Conservation

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills.	Professional Ethics and Social Responsibility
CO1 : Identify various natural resources.	1	2	2	2	2	1	1	2	2	2	3	2	2	3	2	2
CO 2 : Gain knowledge conservation strategies of natural resources.	2	3	2	3	1	2	3	2	1	1	2	2	2	2	2	1
CO3 : Analyse impact of overexploitation of natural resources.	2	2	2	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Describe concept of sustainable development.	3	2	2	2	3	2	3	2	2	1	3	23	3	3	3	2

CO 5: Get information about mineral resources.	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**2**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Identify various natural resources.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1 **Introduction** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Gain knowledge conservation strategies of natural resources.	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9,2.10,2.11,2.12,2.13	Unit-2 **Forest Resources** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.12 ,2.13	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Analyse impact of overexploitation of natural resources.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: **Water Resources** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7 ,3.8,3.9,3.10,3.11,3.12,3.13,3.14	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Describe concept of sustainable development.	SO4.1SO4.2SO4.3SO4.4 SO4.5	4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	Unit-4: Land & Food Resources 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Get information about mineral resources.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: Mineral Resources 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7, 5.8, 5.9, 5.11	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Course Code: 79EV103

Course Title: Environmental Pollution & control Technology

Pre- requisite: Student should have basic knowledge about pollution and its sources.

Rationale: The students studying Environmental Science should possess foundational understanding about pollution and their effects. Students need to be able to identify the types of pollution, the sources of pollution and how they can protect the environment from further pollutants.

Course Outcomes:

79EV 103.1: Describe different sources, types, effects & control methods of air pollution.

79EV103.2: Explain various sources, types, effects and management of pollution.

79EV103.3: Analyse different soil samples.

79EV103.4: Apply noise pollution control technology according to source.

79EV103.5: Discuss the sources & effects of thermal and nuclear pollution.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV103	Environmental Pollution & control Technology	3+1	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV103	Environmental Pollution & control Technology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV103.1: Describe different sources, types, effects & control methods of air pollution.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	10
SW	3
SL	2
Total	27

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO1.1 Learn the primary and secondary pollutants. **SO1.2** Know the transport & diffusion of pollutants. **SO1.3** Observe the effects of pollutants. **SO1.4** Understand methods of air pollution monitoring. **SO1.**5 Learn about pollution control technologies.	1.1 Determination of wind velocity and direction by anemometers- 1 1.2 Determination of wind velocity and direction by anemometers-2 1.3 Determination of PM10 and PM 2.5 in ambient air by Dust Sampler-1 1.4 Determination of PM10 and PM 2.5 in ambient air by Dust Sampler-2 1.5 Monitoring and analysis of Gaseous pollutants-1 1.6 Monitoring and analysis of Gaseous pollutants-2 1.7 Stack monitoring and sampling of pollutants in industry-1 1.8 Stack monitoring and sampling of pollutants in industry-2 1.9 Study of air pollutant control devices in an industry- 1 1.10 Study of air pollutant control devices in an industry- 2	**Unit-1 Air Pollution** **1.1** Definition, Primary and secondary air pollutants **1.2** sources of pollution **1.3** Transport & diffusion of pollutants. **1.4** Effects of pollutants on different components 1.5 Methods of air pollution monitoring and analysis stack sampling & monitoring. 1.6 Role of green belt in air pollution control. 1.7 Engineering methods of air pollution control- Gravity settling chamber. 1.8 Cyclonic precipitators, Electrostatic Precipitators (ESP). 1.9 Fabric filters, Scrubbers- Wet & Dry. 1.10 Catalytic converter & Vehicular emission control.	**1.** Sources of pollutant. 2. Role of an individual in control of air pollution.

		1.11 Personal Protective equipment for Dust & Gaseous pollutants. 1.12 NAAQS by CPCB	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Role of an individual in conservation of air pollution.
ii. National ambient air quality standards by CPCB.
iii. Describe effects of pollutants on different components.
iv. Define air pollution and mention its sources.
v. Describe role of green belt in air pollution control.

b. Mini Project:

i. Personal Protective equipment for Dust & Gaseous pollutants.

c. Other Activities (Specify):

Presentation on Engineering methods of air pollution control.

79EV 103.2: Explain various sources, types, effects and management of pollution.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	11
SW	03
SL	02
Total	27

Session Outcomes	Laboratory Instruction	Class room Instruction (CI)	Self-Learning (SL)

(SOs)	(LI)		
SO2.1 Learn types of water pollution. **SO2.2** Know effects of water pollution. **SO2.3** Analyze water samples. **SO2.4 Learn** about water treatment plants. **SO2.**5 Understand CPCB standards for waste water & drinking water.	2.1 Sampling methods & storage techniques of water & soil-1 2.2 Sampling methods & storage techniques of water & soil-2 2.3 Estimation of temperature, pH, conductivity and turbidity of water samples - 1 2.4 Estimation of temperature, pH, conductivity and turbidity of water samples - 2 2.5 Determination of alkalinity of water samples – 1 2.6 Determination of alkalinity of water samples -2 2.7 Measurement of Acidity, TDS of a water sample - 1 2.8 Measurement of Acidity, TDS of a water sample -2 2.9 Measurement of Acidity, TDS of a water sample -2 2.10 Field visit to river/lake and water and wastewater treatment plants -1 2.11 Field visit to river/lake and water and wastewater treatment plants -2	Unit-2 **Water & Marine Pollution** 2.1 Definition, Types of water pollutants. 2.2 Physical, Chemical & Biological, Sources of water pollutants. 2.3 Effects of water & marine pollution. 2.4 Water Quality Standards 2.5 Physico-chemical & bacteriological sampling and analysis of water. 2.6 Sewage and waste water treatment. 2.7 Bioreactors for waste water treatment 2.8 Design aspects of major units in treatment plant & their functions. 2.9 Thermal pollution 2.10 Marine pollution. 2.11 CPCB standards for waste water & drinking water.	i.Introduction of water pollution ii. Effects of water pollution.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Sewage and waste water treatment

ii. Physico-chemical & bacteriological sampling and analysis of water.
iii. Define air pollution and write its sources.
iv. What do you mean by thermal pollution? Describe in detail.
v. Define marine pollution write its causes and effects.
vi. Discuss about the effects of water pollution.

b. Mini Project:

CPCB standards for waste water & drinking water.

c. Other Activities (Specify):

Visit to local area and collect water samples from difference source.

79EV103.3: Analyse different soil samples.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	02
SW	3
SL	1
Total	19

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Know the sources of soil pollutants. **SO3.2** Learn soil sampling. **SO3.3** Describe Soil micro-organisms and their functions **SO3.4** Analyze soil samples. **SO3.**5 Understand control of soil pollution.	3.1 Physical properties of soil: Determination of textured and particle size distribution -1 3.2 Physical properties of soil: Determination of textured and particle size distribution -1	**Unit-3: Soil Pollution** 3.1 Definition & Sources of soil pollution. 3.2 Effects of soil pollution. 3.3 Sampling of soil. 3.4 Tutorial 1 3.5 Physico-chemical and bacteriological analysis of soil. 3.6 Industrial waste, heavy metals and their interaction with soil components. 3.7 Soil micro-organisms and their functions 3.8 Tutorial 2 3.9 Degradation of different insecticides in soil. 3.10 Degradation of different fungicides in soil. 3.11 Degradation of different	i. What is soil pollution.

		weedicides in soil. 3.12 Control of soil pollution. 3.13Tutorial 3	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Physico-chemical and bacteriological analysis of soil.
ii. Soil micro-organisms and their functions
iii. Describe control of soil pollution.
iv. Discuss sampling method of soil.
v. Mention the effects of soil pollution.

b. Mini Project:

Degradation of different insecticides, fungicides and weedicides in soil.

c. Other Activities (Specify):

Collect the list of water resource nearby you.

79EV 103.4: Apply noise pollution control technology according to source.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	02
SW	3
SL	2
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Learn about Noise pollution. **SO4.2** know Sources of noise pollution. **SO4.3** Understand effects of noise pollution. **SO4.4** Describe	4.1 Measurement of noise of Industrial, Residential & Silent zone-1 4.2 Measurement of noise of Industrial, Residential & Silent zone-1	**Unit-4: Noise Pollution** **4.1** Definition, Sources of noise pollution **4.2** Effects of noise pollution **4.3** Measurement of noise and indices. **4.4** Tutorial 1 **4.5** Effects of meteorological parameters on noise	i. Source of noise pollution. ii. Ear plug and ear muffs.

noise exposure levels and standards. **SO4.**5 understand noise pollution standards by CPCB		propagation **4.6** Noise exposure levels and standards. **4.7** Noise control and abatement measures **4.8** Tutorial 2 **4.9** Plants that control noise **4.10** PPE to control noise **4.11** Noise barriers **4.12** Noise pollution standards by CPCB. **4.13** Tutorial 3	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Write about different sources of noise.
ii. Describe briefly the noise control and abatement measures.
iii. Describe noise exposure levels and standards.
iv. What do you mean by noise barriers? Explain.

b. Mini Project:

i. Make a PPT on PPE to control noise.

c. Other Activities (Specify):

Collect the data of noise level from different sources.

79EV 103.5: Discuss the sources & effects of thermal and nuclear pollution.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 know the sources of nuclear and thermal pollution.		**Unit-5: Nuclear & Thermal pollution** 5.1 Definition & sources of nuclear pollution	i. What are radioactive elements? ii. Sources of

SO5.2 Understand effects of nuclear pollution. **SO5.3** Describe causes of thermal pollution. **SO5.4** Learn the detection of nuclear radiation. **SO5.**5 Understand control of thermal pollution.		5.2 Biological effects of radiation 5.3 Causes of thermal pollution 5.4 Tutorial 1 5.5 Consequences of thermal pollution. 5.6 Models of radioactive decay 5.7 Tutorial 2 5.8 Detection of nuclear radiations. 5.9 Control of thermal pollution. – 1 5.10 Control of thermal pollution. – 2 5.11 Tutorial 3	radiation. vi.

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

i. Definition, sources and effects of thermal pollution.
ii. Define nuclear pollution and write its sources.

b. Mini Project:

Prepare a chart on the biological effects of radiation

c. Other Activities (Specify):

Models of radioactive decay

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV 103.1: Describe different sources, types, effects & control methods of air pollution.	12	0	3	2	17
79EV 103.2: Explain various sources, types, effects and management of pollution.	11	0	3	2	16
79EV103.3: Analyze	13	0	3	1	17

different soil samples.					
79EV 103.4**:** Apply noise pollution control technology according to source.	13	0	3	2	18
79EV 103.5: Discuss the sources & effects of thermal and nuclear pollution.	11	0	3	2	16
Total Hours	60	00	15	9	84

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Air Pollution**	03	01	01	05
CO-2	**Water & Marine Pollution**	02	06	02	10
CO-3	**Soil Pollution**	03	07	05	15
CO-4	**Noise Pollution**	-	10	05	15
CO-5	**Nuclear & Thermal pollution**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method

4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Environmental Problems and Solution	D.K. Asthana	S.Chand and Company, New Delhi.	2001
2	Air Pollution	B. K. Sharma, H. Kaur	Krishna prakashan media, Meerut	2019
3	Water Pollution	V. P. Kudesia	Pragati Prakashan, Meerut	2017
4	Soil pollution & Soil organisms	P. C. Mishra	A P H Publishing Corporation	2008

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV103

Course Title: Environmental Pollution & control Technology

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Describe different sources, types, effects & control methods of air pollution.	2	3	3	2	3	3	3	2	2	1	3	2	2	3	3	1
CO 2: Explain various sources, types, effects and management of pollution.	2	3	3	2	3		3	2	1	1	2	2	2	2	2	1
CO3: Analyse different soil samples.	2	3	3	3	3	2	2	2	1	2	1	2	1	1	2	2

CO 4: Apply noise pollution control technology according to source.	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Discuss the sources & effects of thermal and nuclear pollution.	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Describe different sources, types, effects & control methods of air pollution.	SO1.1SO1.2SO1.3SO 1.4 SO1.5	1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10	Unit-1 **Air Pollution** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Explain various sources, types, effects and management of pollution.	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10,2.11	Unit-2 **Water & Marine Pollution** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Analyse different soil samples.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2	Unit-3: **Soil Pollution** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7, 3.8,3.9,3.10,3.11,3.12,3.13	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Apply noise pollution control technology according to source.	SO4.1SO4.2SO4.3SO 4.4 SO4.5	4.1,4.2	Unit-4: **Noise Pollution** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7 ,4.8,4.9,4.10, 4.11,4.13,4.13	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Discuss the sources & effects of thermal and nuclear pollution.	SO5.1SO5.2SO5.3SO 5.4 SO5.5		Unit 5: **Nuclear & Thermal pollution** 5.1,5.2,5.3,5.4,5.5,5.6, 5.7,5.8,5.9,5.10,5.11	

Course Code: 79EV104

Course Title: Environmental chemistry

Pre- requisite: Student should have basic knowledge

Rationale: The students studying Environmental Science should possess foundational understanding about green chemistry. It involves first understanding how the uncontaminated environment works, which chemicals in what concentrations are present naturally and with what effects.

Course Outcomes:

79EV 104.1: Describe the various chemical processes occurring in the air, water and soil.

79EV104.2: Discuss the effect of hydrocarbons and synthetic compounds on biological organisms.

79EV104.3: Explain the degradation of hydrocarbon and synthetic compounds.

79EV104.4: Illustrate the working principle, merits and demerits of analytical techniques.

79EV104.5: Apply Green Chemistry for Sustainable Future.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV104	Environmental Chemistry	3+1	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 2 marks each	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+ AT)		
PCC	79EV104	Environmental Chemistry	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV104.1: Describe different sources, types, effects & control methods of air pollution.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	3
SL	2
Total	19

Session Outcomes	Laboratory	Class room Instruction	Self-Learning

(SOs)	Instruction (LI)	(CI)	(SL)
SO1.1 Understand the concept of environmental chemistry. **SO1.2** Know the scopes of environmental chemistry. **SO1.3** Learn the Stochiometry. **SO1.4** Know acid base reactions. **SO1.**5 Learn about Unsaturated & saturated hydrocarbons		**Unit-1 Fundamental** 1.1 Concept of environmental chemistry. 1.2 Scope of environmental chemistry 1.3 Stochiometry 1.4 Tutorial 1 1.5 Gibb's energy 1.6 Chemical potential 1.7 Acid base reactions 1.8 solubility product 1.9 Tutorial 2 1.10 solubility of gases in water 1.11 Carbonate system 1.12 Unsaturated & saturated hydrocarbons 1.13 Radionuclides 1.14 Tutorial 3	i. What is environmental chemistry? ii. Basic knowledge about Acid base.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. solubility of gases in water
ii. Chemical potential
iii. Carbonate system
iv. Unsaturated & saturated hydrocarbons

b. Mini Project:

i. Scope of environmental chemistry

c. Other Activities (Specify):

Presentation on acid base reactions.

79EV 104.2: Discuss the effect of hydrocarbons and synthetic compounds on biological organisms.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	3

SL	2
Total	19

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Learn Classification of elements. **SO2.2** Know about Particles, ions and radicals in the atmosphere. **SO2.3** Understand Chemical processes for formation of inorganic particulate matter. **SO2.4** Describe the **p**hotochemical reactions in the atmosphere **SO2.**5 Understand chemistry of oxygen & ozone.		Unit-2 **Atmospheric Chemistry** 2.1 Classification of elements 2.2 Chemical speciation 2.3 Particles, ions and radicals in the atmosphere, 2.4 Chemical processes for formation of inorganic particulate matter 2.5 Chemical processes for formation of organic particulate matter 2.6 Thermochemical reactions 2.7 Tutorial 1 2.8 Photochemical reactions in the atmosphere 2.9 Oxygen & ozone chemistry 2.10 Chemistry of air pollutants 2.11 Photochemical smog 2.12 Acid rain- Fundamental 2.13 Effects of acid rain 2.14 Tutorial 2	i.Introduction of atmosphere ii. Effects of ozone

SW-2 Suggested Sessional Work (SW):

1. **Assignments:**
   i. Classification of elements
   ii. Chemical processes for formation of organic particulate matter.
   iii. Define acid rain write its causes and effects.
   iv. Describe Chemical processes for formation of inorganic particulate matter.

2. **Mini Project:**
   Write a report on acid rain
3. **Other Activities (Specify):**
   Chemistry of air pollutants.

79EV104.3: Explain the degradation of hydrocarbon and synthetic compounds.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Know the Properties of water. **SO3.2** Learn the chemistry of water. **SO3.3** Understand the concept of BOD. **SO3.4** Analyze water sample. **SO3.**5 Understand coagulation & filtration.		**Unit-3: Water Chemistry** 3.1 Properties of water 3.2 Chemistry of water 3.3 Tutorial 1 3.4 Concept of DO 3.5 Concept of BOD 3.6 COD 3.7 Tutorial 2 3.8 Sedimentation 3.9 Coagulation, filtration 3.10 Redox potential. 3.11 Tutorial 3	i. What is water pollution? ii. Characteristics of potable water.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Water quality standard by CPCB.
ii. Describe the properties of water.
iii. Describe sedimentation coagulation & sedimentation.

b. Mini Project:

DO, BOD, COD

c. Other Activities (Specify):

Collect the water sample from different sources and determine DO, BOD & C

79EV 104.4: Explain the degradation of hydrocarbon and synthetic compounds.

Approximate Hours

Item	AppX Hrs
Cl	10
LI	0
SW	4
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Learn about formation of soil. **SO4.2** know Constituents and properties of soils. **SO4.3** Understand Inorganic Components of soil. **SO4.4** Describe Organic components of soil. **SO4.**5 Analyze NPK in soils.		**Unit-4: Soil Chemistry** 4.1 Formation of soil 4.2 Constituents and properties of soils 4.3 Tutorial 1 4.4 Adsorption of contaminants 4.5 Inorganic Components of soil 4.6 Tutorial 2 4.7 Organic components of soil 4.8 Nitrogen pathways 4.9 NPK in soils. 4.10 Tutorial 3	i. Chemical biological weathering of soil. ii. Components of soil

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Write about method of soil formation.
ii. Describe constituents and properties of soils.

b. Mini Project:

i. Make a PPT on nitrogen pathways.

c. Other Activities (Specify):
Collect the data of NPK in soil.

79EV 104.5: Apply Green Chemistry for Sustainable Future.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 know about the reagents. **SO5.2** Understand the importance of solvents. **SO5.3** Describe Synthetic and Processing Pathways. **SO5.4** Learn the Zero waste technology. **SO5.**5 Understand the Principles and Application of Green Chemistry.		**Unit-5: Green Chemistry for Sustainable Future** 5.1 Reagents 5.2 Media 5.3 Special Importance of Solvents 5.4 Water the Greenest Solvents 5.5Synthetic and Processing Pathways 5.6 Role of Catalyst 5.7 Biological Alternatives 5.8 Biopolymers 5.9 Principles and Application of Green Chemistry 5.10 Zero waste technology 5.11 Tutorial 1	i. What is green chemistry? ii. Basic information about reagents and media.

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

i. Describe Reagents and Media.
ii. Write the principles and application of green chemistry.
iii. Mention special importance of solvents.
iv. What do you mean by synthetic and Processing Pathways? Explain.

b. Mini Project:

Prepare some media in green chemistry lab

Other Activities (Specify):

Models of zero waste technology.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV104.1: Describe the various chemical processes occurring in the air, water and soil.	14	00	3	2	19
79EV104.2: Discuss the effect of hydrocarbons and synthetic compounds on biological organisms.	14	00	3	2	19
79EV104.3: Explain the degradation of hydrocarbon and synthetic compounds.	11	00	3	1	15
79EV 104.4: Illustrate the working principle, merits and demerits of analytical techniques.	10	00	3	2	15
79EV104.5: Apply Green Chemistry for Sustainable Future.	11	00	3	1	15
Total Hours	60	00	15	8	83

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Atmospheric Chemistry**	02	06	02	10
CO-3	**Water Chemistry**	03	07	05	15
CO-4	**Soil Chemistry**	-	10	05	15
CO-5	**Green Chemistry for Sustainable Future**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Environmental Chemistry	B.K. Sharma, and H. Kaur	Goel Publishing House,	1997
2	Environmental Chemistry	Manahan	Stanely Lewis Publishers	1972

3	Elements of Environmental Chemistry	H. V. Jadhav	Himalaya,Publishing House	1992
4	Environmental Chemistry with Green Chemistry	Asim K. Das	Books and Allied (P) LTD. Kolkata.	2014

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV104

Course Title: Environmental chemistry

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Describe the various chemical processes occurring in the air, water and soil.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2: Discuss the effect of hydrocarbons and synthetic compounds on biological organisms.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Explain the degradation of hydrocarbon and synthetic compounds.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2

CO 4: Illustrate the working principle, merits and demerits of analytical techniques.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Apply Green Chemistry for Sustainable Future.	**2**	**3**	**2**	**3**	**1**	**1**	**3**	**3**	**1**	**2**	**3**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Describe the various chemical processes occurring in the air, water and soil.	SO1.1SO1.2SO1.3SO1.4 SO1.5	1.1, 1.2, 1.3, 1.4, 1.5, 1.6,1.7	Unit-1 **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7, 1.8,1.9,1.10,1.11,1.12,1.13,1.14	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Discuss the effect of hydrocarbons and synthetic compounds on biological organisms.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Atmospheric Chemistry** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7 , 2.8,2.9,2.10,2.11,2.13,2.14	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Explain the degradation of hydrocarbon and synthetic compounds.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12,3.13	Unit-3: **Water Chemistry** 3.1, 3.2,3.3,3.4,3.5, 3.6,3.7,3.8,3.9,3.10,3.11	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Illustrate the working principle, merits and demerits of analytical techniques.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Soil Chemistry** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Apply Green Chemistry for Sustainable Future.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **Green Chemistry for Sustainable Future** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8,5.9,5.10,5.11	

Semester-I

Course Code: **79EV151**

Course Title: Practical Lab-1

Pre- requisite: Student should have basic knowledge of Ecology, Biostatistics and sampling.

Rationale: Practical in ecology and biodiversity are essential for understanding the complex interactions within ecosystems and the diversity of life forms. They provide hands-on experience in observing, measuring, and analyzing ecological relationships and biodiversity patterns, which are crucial for accurate environmental assessment and conservation strategies. Through fieldwork, lab experiments, and data analysis, students gain a deeper appreciation of ecological principles, the impact of human activities on natural habitats, and the importance of preserving biodiversity. These practical also develop critical skills such as scientific inquiry, data interpretation, and problem-solving, preparing students for careers in environmental science, conservation, and related fields.

Course Outcomes:

79EV151.1: Identify the optimal quadrate size for accurate community sampling, ensuring reliable ecological data collection and analysis.

79EV151.2: Acquire skills to quantify plant populations and their spatial distribution, providing insights into community structure and dynamics.

79EV151.3: Learn to calculate and interpret IVI, enabling them to assess the relative significance of different species within a community.

79EV151.4: Proficient in using the Simpson index to measure species diversity, understanding its implications for ecosystem stability and health.

79EV151.5: Evaluate species richness, evenness, and dominance, offering a comprehensive view of biodiversity and species interactions.

Scheme of Studies:

Board of Study				Scheme of studies (Hours/Week)	Total Credits

	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	(C)
Program Laboratory course (PLC)	**79EV151**	Practical Lab-1	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV+ +TA)		
PLC	79EV151	Practical Lab-1	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV151.1: Identify the optimal quadrate size for accurate community sampling, ensuring reliable ecological data collection and analysis.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Enhanced Field Research Skills. **SO1.2** Data Analysis and Interpretation. **SO1.3** Ecological Assessment Proficiency. **SO1.4** Understanding Ecosystem Dynamics. **SO1.**5 Application of Theoretical Knowledge.	**Unit-1** 1.1 Determination of minimum size of quadrate for community study – 1 1.2 Determination of minimum size of quadrate for community study – 2 1.3 Determination of minimum size of quadrate for community study – 3 1.4 Determination of minimum size of quadrate for community study – 4 1.5 Determination of density, frequency, abundance and dominance of plant species using quadrat method -1 1.6 Determination of density, frequency, abundance and dominance of plant species using quadrat method -2 1.7 Determination of density, frequency, abundance and dominance of plant species using quadrat method -3 1.8 Determination of density,		1.What is Quadrate? 2.Frequency and density.

	frequency, abundance and dominance of plant species using quadrat method -4 1.9 Determination of density, frequency, abundance and dominance of plant species using quadrat method -5		

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Determination of density

b. Mini Project:
i. Find out the frequency of plants by quadrate methods.

c. Other Activities (Specify):
Write about the diversity of your surroundings.

79EV151.2: Acquire skills to quantify plant populations and their spatial distribution, providing insights into community structure and dynamics.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Understanding IVI Components. **SO2.2** Data Collection Proficiency. **SO2.3** Ecological	**Unit-2** 2.1 Calculation of the Importance Value Index (IVI) of species – 1 2.2 Calculation of the		1.What is IVI?

Interpretation. **SO2.4** Calculation of Simpson Index. **SO2.**5 Field Sampling Techniques.	Importance Value Index (IVI) of species – 2 2.3 Calculation of the Importance Value Index (IVI) of species – 3 2.4 Calculation of the Importance Value Index (IVI) of species – 4 2.5 Determination of diversity by Simpson index - 1 2.6 Determination of diversity by Simpson index - 2 2.7 Determination of diversity by Simpson index - 3 2.8 Determination of diversity by Simpson index - 4 2.9 Determination of diversity by Simpson index - 5		

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Assess species diversity within a community using the Simpson Index, interpreting the results to understand the relative abundance and distribution of species.

b. **Mini Project:**
Analyze the findings and compile a comprehensive report, demonstrating their ability to communicate the significance of the Simpson Index in biodiversity studies and its role in environmental science.

c. **Other Activities (Specify):**
Use field sampling techniques to gather data for the Simpson Index calculation, including identifying and counting species in a defined study area.

79EV151.3: Learn to calculate and interpret IVI, enabling them to assess the relative significance of different species within a community.

Approximate Hours

Item	AppX Hrs
Cl	0

LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Understand the interactions between different biotic components. **SO3.2** Identify and classify various biotic components present in the pond ecosystem. **SO3.3** Application of Diversity Indices. **SO3.4** develop skills in interpreting the calculated richness, evenness, and dominance values, drawing meaningful conclusions about the ecological health, stability, and biodiversity of the studied environment. **SO3.**5 Understanding Species Richness.	**Unit-3** 3.1 Calculation of richness, evenness and dominance of species – 1 3.2 Calculation of richness, evenness and dominance of species – 2 3.3 Calculation of richness, evenness and dominance of species – 3 3.4 Calculation of richness, evenness and dominance of species – 4 3.5 Calculation of richness, evenness and dominance of species – 5 3.6 To study the biotic components of a pond eco system – 1 3.7 To study the biotic components of a pond eco system – 2 3.8 To study the biotic components of a pond eco system – 3 3.9 To study the biotic components of a pond eco system – 4		1. What is species richness?

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
Calculate species richness, identifying the total number of different species present within a given ecological sample or environment.

b. **Mini Project:**
Visit to pond near your locality & make chart of pond ecosystem.

c. **Other Activities (Specify):**
Calculation of evenness of species

79EV151.4: Proficient in using the Simpson index to measure species diversity, understanding its implications for ecosystem stability and health.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Identify and classify the various species of plants, insects, and other animals that inhabit the grassland ecosystem. **SO4.2**. Learn techniques to measure the population density of different species within the grassland ecosystem. **SO4.3** Assess the biodiversity of the grassland	**Unit-4** 4.1 To study a biotic component of a grassland ecosystem – 1 4.2 To study a biotic component of a grassland ecosystem – 2 4.3 To study a biotic component of a grassland ecosystem – 3 4.4 To study a biotic component of a grassland ecosystem – 4 4.5 Calculation of similarity index between two		1. What is similarity index?

ecosystem, including species richness and evenness. **SO4.4** Develop skills in data analysis, specifically in calculating similarity indices between two communities. **SO4.**5 Discuss the ecological implications of the similarity or dissimilarity between the communities	adjoining communities-1 4.6 Calculation of similarity index between two adjoining communities-2 4.7 Calculation of similarity index between two adjoining communities-3 4.8 Calculation of similarity index between two adjoining communities-4 4.9 Calculation of similarity index between two adjoining communities-5		

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Identify and classify the various species of plants, insects, and other animals that inhabit the grassland ecosystem.

b. **Mini Project:**

Describe structure and composition of the two communities, including dominant species and species turnover.

79EV151.5: Evaluate species richness, evenness, and dominance, offering a comprehensive view of biodiversity and species interactions.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**

SO5.1 Learn proper soil sampling techniques. **SO5.2**. Gain practical skills in laboratory methods for measuring soil moisture content, pH levels, and electrical conductivity. **SO5.3** Develop the ability to interpret the results of soil tests to understand how different land uses affect soil properties. **SO5.4** Learn various techniques for accurately measuring tree height, trunk height, and canopy cover. **SO5.**5 Develop the ability to identify tree species based on morphological characteristics, such as leaf shape, bark texture, and reproductive structures	**Unit-5** 5.1 Estimation of moisture, pH and conductivity of soils under different land uses – 1 5.2 Estimation of moisture, pH and conductivity of soils under different land uses – 2 5.3 - Estimation of moisture, pH and conductivity of soils under different land uses – 3 5.4 Determination of tree height, trunk height & canopy cover & Its importance – 1 5.5 Determination of tree height, trunk height & canopy cover & Its importance – 2 5.6 Determination of tree height, trunk height & canopy cover & Its importance – 3 5.7 Determination of tree height, trunk height & canopy cover & Its importance – 4 5.8 Identification of tree species at AKSU campus – 1 5.9 Identification of tree species at AKSU campus – 2		1.What is tree Hight & trunk height?

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Discuss the ecological roles and aesthetic value of the identified tree species, considering their contributions to campus biodiversity, shade provision, and landscape beauty.

b. Mini Project:

Document the biodiversity of tree species on the AKSU campus, creating a comprehensive inventory of tree species present.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV151.1: Identify the optimal quadrate size for accurate community sampling, ensuring reliable ecological data collection and analysis.	0	18	2	1	21
79EV151.2: Acquire skills to quantify plant populations and their spatial distribution, providing insights into community structure and dynamics.	0	18	2	1	21
79EV151.3: Learn to calculate and interpret IVI, enabling them to assess the relative significance of different species within a community.	0	18	2	1	21
79EV151.4: Proficient in using the Simpson index to measure species diversity, understanding its implications for ecosystem stability and health.	0	18	2	1	21
79EV151.5: Evaluate species richness, evenness, and dominance, offering a comprehensive view of biodiversity and species interactions.	0	18	2	1	21
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10
CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Practical Manual of Ecology and Environment Science	Rina Majumdar & Renuka Kashyap	*Prestige Books*	2019
2	Practical Manual of Ecology and Environment Science	P. D. Sharma	Rastogi Publications	2011
3	Experimental Ecology: Issues and Perspectives	Joseph Bernardo (Editor), William J.Resetarits ,	Oxford University Press	2001

4	Methods in Comparative Plant Ecology: A laboratory manual	G.A. Hendry, J.P. Grime	Springer Science & Business Media	1993
5	Experimental Approaches to Conservation Biology	MALCOLM S. GORDON SORAYA M. BARTOL	University of California Press	2004

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV151
Course Title: Practical Lab – 1

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Identify the optimal quadrate size for accurate community sampling, ensuring reliable ecological data collection and analysis.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Acquire skills to quantify plant populations and their spatial distribution, providing insights into community structure and dynamics.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

CO3: Learn to calculate and interpret IVI, enabling them to assess the relative significance of different species within a community.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Proficient in using the Simpson index to measure species diversity, understanding its implications for ecosystem stability and health.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO 5 Evaluate species richness, evenness, and dominance, offering a comprehensive view of biodiversity and species interactions.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Identify the optimal quadrate size for accurate community sampling, ensuring reliable ecological data collection and analysis.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Acquire skills to quantify plant populations and their spatial distribution, providing insights into community structure and dynamics.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Learn to calculate and interpret IVI, enabling them to assess the relative significance of different species within a community.	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4 Proficient in using the Simpson index to measure species diversity, understanding its implications for ecosystem stability and health.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Evaluate species richness, evenness, and dominance, offering a comprehensive view of biodiversity and species interactions.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

Semester-I

Course Code: **79EV152**

Course Title: Practical Lab-2

Pre- requisite: Student should have basic knowledge of Rules and regulations of laboratory & preparation of standard solutions.

Rationale: Understanding laboratory concepts, including rules and regulations, and the preparation of standard solutions is fundamental for M.Sc. Environmental Science students. This knowledge ensures safety, accuracy, and reliability in scientific research. Proper adherence to lab protocols minimizes the risk of accidents and contamination, while mastery in preparing standard solutions underpins the precision required in quantitative analyses, forming the basis for all subsequent experimental procedures.

Course Outcomes:

79EV152.1: Understand and adhere to laboratory safety protocols and regulations.

79EV152.2: Gain familiarity with various digital laboratory instruments, such as spectrophotometers, pH meters, and conductivity meters.

79EV152.3: Learn standardized sampling protocols for collecting water and soil samples from various environments.

79EV152.4: Learn and apply standard methods for water quality analysis, ensuring consistency and accuracy.

79EV152.5: Analyze noise data to assess compliance with environmental noise regulations and standards.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Laboratory course (PLC)	**79EV152**	Practical Lab-2	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV+ +TA)		
PLC	79EV152	Practical Lab-2	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV152.1: Understand and adhere to laboratory safety protocols and regulations.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Understanding Laboratory Safety. **SO1.2** Preparation of Standard Solutions. **SO1.3** Analysis Preparation. **SO1.4** Data Recording and Interpretation. **SO1.**5 Documentation of Sampling Process.	**Unit-1** a.1 Laboratory concepts: Rules and regulation, preparation of standard solutions – 1 a.2 Laboratory concepts: Rules and regulation, preparation of standard solutions- 2 a.3 Handling of digital instruments of laboratory – 1 a.4 Handling of digital instruments of laboratory – 2 a.5 Handling of digital instruments of laboratory – 3 a.6 Sampling methods & storage techniques of water & soil - 1 a.7 Sampling methods & storage techniques of water & soil - 2 a.8 Sampling methods & storage techniques of water & soil - 3 a.9 Sampling methods & storage techniques of water & soil - 4		1.What is Sampling? .

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Maintain detailed records of the sampling process, including location, time, method used, and any observations relevant to the sample collection.

b. Mini Project:

Prepare samples for analysis by following proper storage techniques, ensuring that samples remain viable and uncontaminated for subsequent testing and evaluation.

c. Other Activities (Specify):

Apply proper calibration techniques for digital instruments to ensure accurate measurements and will understand the basic maintenance requirements to keep the instruments in good working condition.

79EV152.2: Gain familiarity with various digital laboratory instruments, such as spectrophotometers, pH meters, and conductivity meters.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Understanding Measurement Techniques. **SO2.2** Understanding Noise Pollution. **SO2.3** Recommendations and Reporting. **SO2.4** Documentation and Presentation. **SO2.**5 Field Sampling Techniques.	**Unit-2** 2.1 Estimation of temperature, pH, conductivity and turbidity of water samples – 1 2.2 Estimation of temperature, pH, conductivity and turbidity of water samples -2 2.3 Estimation of temperature, pH, conductivity and turbidity		1. What is conductivity and turbidity?

	of water samples – 3 2.4 Measurement of noise of Industrial, Residential & Silent zone – 1 2.5 Measurement of noise of Industrial, Residential & Silent zone – 2 2.6 Measurement of noise of Industrial, Residential & Silent zone – 3 2.7 Determination of alkalinity of water samples – 1 2.8 Determination of alkalinity of water samples – 2 2.9 Determination of alkalinity of water samples – 3		

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Concept of alkalinity, its importance in water chemistry, and its impact on water quality and aquatic life.

b. **Mini Project:**
Record noise level data, analyze it to understand the impact of different noise sources in each zone.

Other Activities (Specify):
Practice the correct techniques for measuring temperature, pH, conductivity, and turbidity of water samples using appropriate instruments and methodologies.

79EV152.3: Learn standardized sampling protocols for collecting water and soil samples from various environments.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2

SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Learn to measure and interpret the pH levels of various water samples. **SO3.2** measure Total Dissolved Solids (TDS) in water samples using appropriate equipment**.** **SO3.3** Gain hands-on experience in calibrating pH meters and TDS meters to ensure accurate readings. **SO3.4** understand how soil texture affects other soil properties such as water retention, permeability, and fertility. **SO3.**5 learn to set up and use different types of anemometers.	**Unit-3** 3.1 Measurement of Acidity, TDS of a water sample - 1 3.2 Measurement of Acidity, TDS of a water sample - 2 3.3 Measurement of Acidity, TDS of a water sample – 3 3.4 Physical properties of soil: Determination of textured and particle size distribution – 1 3.5 Physical properties of soil: Determination of textured and particle size distribution – 2 3.6 Physical properties of soil: Determination of textured and particle size distribution – 3 3.7 Determination of wind velocity and direction by anemometers – 1 3.8 Determination of wind velocity and direction by anemometers – 2 3.9 Determination of wind velocity and direction by anemometers – 3		1. What is TDS & acidity of water?

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Measure and interpret the pH levels of various water samples, understanding the significance of acidity and alkalinity in water quality.

b. Mini Project:

Classify soil samples into different texture categories (e.g., sandy, loamy, clayey) based on particle size distribution.

c. . Other Activities (Specify):

Describe the the importance of wind measurements in weather forecasting and climate studies.

79EV152.4: Learn and apply standard methods for water quality analysis, ensuring consistency and accuracy.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understand the principles behind psychrometric measurements. **SO4.2**. Understand the significance of Biological Oxygen Demand as an indicator of organic pollution in water bodies. **SO4.3** Handling and use of reagents and chemicals required for COD determination. **SO4.4** Develop proficiency in the Winkler method for estimating dissolved	**Unit-4** 4.1 Determination of Temperature, relative humidity by psychomotor. 4.2 Determination of Biological Oxygen Demand of water sample. 4.3 Determination of Chemical Oxygen Demand (COD) of water sample. 4.4 Estimation of dissolved oxygen (DO) of water samples.		1. What is BOD & COD?

oxygen in water samples. **SO4.**5 Learn the correct procedures for collecting and preparing water samples for BOD analysis.			

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Analyze DO data and understanding its relationship with other water quality parameters.

b. **Mini Project:**

Write the principle behind psychrometric measurements and the role of dry and wet bulb temperatures in determining relative humidity.

79EV152.5: Analyze noise data to assess compliance with environmental noise regulations and standards.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Gain hands-on experience in setting up and operating dust samplers. **SO5.2** Learn various techniques for sampling and monitoring	**Unit-5** 5.1 Determination of PM10 and PM 2.5 in ambient air by Dust Sampler – 1 5.2 Determination of PM10 and PM 2.5 in ambient air by Dust Sampler – 2		2. What is species richness?

gaseous pollutants such as NOx, SOx, CO, and O3. **SO5.3** Gain practical knowledge of stack sampling techniques used to measure pollutant emissions from industrial sources. **SO5.4** Learn about various air pollutant control devices used in industries. **SO5.**5 Gain hands-on experience in inspecting and evaluating the performance of air pollutant control devices in a real industrial setting.	5.3 Monitoring and analysis of Gaseous pollutants – 1 5.4 Monitoring and analysis of Gaseous pollutants – 2 5.5 Stack monitoring and sampling of pollutants in industry – 1 5.6 Stack monitoring and sampling of pollutants in industry – 2 5.7 Study of air pollutant control devices in an industry – 1 5.8 Study of air pollutant control devices in an industry – 2 5.9 Study of air pollutant control devices in an industry – 3		

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Discuss about various air pollutant control devices used in industries, such as scrubbers, electrostatic precipitators, and baghouse filters.

b. **Mini Project:**
Explain the impacts associated with exposure to PM10 and PM2.5, including respiratory and cardiovascular issues.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV152.1: Understand and adhere to laboratory safety protocols and	0	18	2	1	21

regulations.					
79EV152.2: Gain familiarity with various digital laboratory instruments, such as spectrophotometers, pH meters, and conductivity meters.	0	18	2	1	21
79EV152.3: Learn standardized sampling protocols for collecting water and soil samples from various environments.	0	18	2	1	21
79EV152.4: Learn and apply standard methods for water quality analysis, ensuring consistency and accuracy.	0	18	2	1	21
79EV152.5: Analyze noise data to assess compliance with environmental noise regulations and standards.	0	18	2	1	21
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10
CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Air Pollution Control Technology Handbook	Karl B Schnelle, Mary Ellen Ternes	CRC Press	2017
2	Experiments in Environmental Chemistry: A Laboratory Manual	P. D. Vowles, D. W. Connell	Pergamon	2013
3	A Laboratory Manual for Environmental Chemistry	R. Gopalan & Amritha Anand & R. Wilgred Sugumar	Techsar	
4	A LAB TEXT BOOK ON Environmental Studies	Dr. A.K. Jain, Dr.Era Upadhayay, Mr Anupam Adhikary	School of Applied. Science AnsalInstitute Of Technology	2011

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV152
Course Title: Practical Lab – 2

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Understand and adhere to laboratory safety protocols and regulations.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Gain familiarity with various digital laboratory instruments, such as spectrophotometers, pH meters, and conductivity meters.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**
CO3: Learn standardized sampling protocols for collecting water and soil	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

samples from various environments.																
CO 4: Learn and apply standard methods for water quality analysis, ensuring consistency and accuracy.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO 5 Analyze noise data to assess compliance with environmental noise regulations and standards.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Understand and adhere to laboratory safety protocols and regulations.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Gain familiarity with various digital laboratory instruments, such as spectrophotometers, pH meters, and conductivity meters.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Learn standardized sampling protocols for collecting water and soil samples from various environments.	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4 Learn and apply standard methods for water quality analysis, ensuring consistency and accuracy.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Analyze noise data to assess compliance with environmental noise regulations and standards.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

Semester I

Course Code: **79EV153**

Course Title: **Seminar/workshop**

Pre- requisite: Basic Knowledge of Power Point Presentation.

Rationale: Seminars and workshops are vital for M.Sc. Environmental Science students as they provide opportunities to learn about the latest research, technologies, and practices in the field. They offer a platform for networking with professionals, experts, and peers, fostering collaboration and knowledge exchange. These events also enhance students' presentation and communication skills, preparing them for future academic and professional endeavours. Furthermore, they allow students to gain hands-on experience and practical insights that complement their theoretical knowledge.

Course Outcomes:

79EV153.1: Understand contemporary environmental challenges and advancements through expert presentations and discussions, enabling them to stay current with the latest trends and research in the field.
79EV153.2: Improve their ability to conduct rigorous environmental research and effectively communicate their findings through presentations, posters, and written reports.
79EV153.3: Learn to collaborate across disciplines, integrating diverse perspectives and expertise to address complex environmental problems, fostering a holistic approach to environmental science.
79EV153.4: Build professional networks with peers, academics, and industry professionals, creating opportunities for future collaborations, internships, and career advancements in the environmental sector.
79EV153.5: Apply theoretical concepts learned in the classroom to real-world environmental issues, enhancing their problem-solving abilities and practical skills.

Scheme of Studies:

Course Category	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
P_fCC	79EV153	Seminar/workshop	0	0	0	0	0	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Seminar/Workshop

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)			
			End Semester Assessment (ESA)			
			Report of Seminar	Presentation	Viva - Voce	Total Marks
P_fCC	79EV153	Seminar/Workshop	40	20	40	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Guidelines for Seminar reports & the presentation

The Topic of Seminar can be selected and carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their seminar report in the department as per the date announced for the submission.

A PowerPoint presentation of selected topic will be prepared by student as per guideline/ instructions of allotted supervisor. Assessment of the Seminar will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates.

- The paper size to be used should be A-4 size.
- The font size should be12 with Times New Roman.
- The text of the seminar will be typed in 1.5 (one and half) space

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping Programme Title: M.Sc. Environmental Science

Course Code: 79EV153

Course Title: Seminar/Workshop

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Understand contemporary environmental challenges and advancements through expert presentations and discussions, enabling them to stay current with the latest trends and research in the field.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Improve their ability to conduct rigorous environmental	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

research and effectively communicate their findings through presentations, posters, and written reports.																
CO3: Learn to collaborate across disciplines, integrating diverse perspectives and expertise to address complex environmental problems, fostering a holistic approach to environmental science.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Build professional networks with peers, academics, and industry professionals, creating opportunities for future collaborations, internships, and career advancements in the environmental sector.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO5: Apply theoretical concepts learned in the classroom to real-world environmental issues, enhancing their problem-solving abilities and practical skills.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: 79EV201

Course Title: Energy & Environment

Pre-requisite: Student should have basic knowledge of Environment & Energy.

Rationale: The students studying Environmental & Energy will possess the knowledge of energy technologies in improved ways without effecting human health as well as pollution free environment.

Course Outcomes:

79EV 201.1: Describe Energy audits for building.

79EV201.2: Explain energy efficient lighting technologies and its application in commercial and residential sectors.

79EV201.3: Describe Energy audits for building.

79EV201.4: Implement Energy storage technologies and Energy Auditing

79EV201.5: Learn the techniques of energy conservation.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV201	Energy & Environment	3+1	0	1	1	6	4

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practice performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (include assignment, seminar, mini project etc.),

SL: Self earning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV201	Energy & Environment	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion

79EV201.1: Describe Energy audits for building.

Approximate Hours

Item	AppX Hrs.
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Out comes (SOs)	Laboratory Instruction	Class room Instruction (CI)	Self-Learning (SL)

	(LI)		
SO1.1 Understand the energy requirement. **SO1.2**Different forms of energy used in world. **SO1.3**Impact of energy use pattern in world & environment. **SO1.4**Energy use pattern in India **SO1.5** Different sources of energy, global balance of energy and various problems faced due to energy use. .		**Unit-1Introduction** **1.1** Human energy requirement **1.2** Energy use pattern in different parts of the world **1.3** Tutorial-1 **1.4** Energy use pattern in different parts of the world and its impact on the environment **1.5** Energy use pattern in India **1.6** Sources of energy **1.7** Energy resources classification **1.8** Energy forms and transformation. **1.9** Tutorial-2 **1.10** Global energy balance **1.8** Problems related to various energy uses. **1.11** Tutorial-3 **1.12** Brief introduction to energy sources and problems faced due to energy use.	1. Human energy requirement. **2.** Problems faced due to energy use.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Different sources of energy resources.

b. Mini Project:

Problems faced due to energy resources.

c. Other Activities (Specify):

Global energy balance

79EV 201.2: Explain energy efficient lighting technologies and its application in commercial and residential sectors.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Out comes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO2.1 To understand current energy scenario. **SO2.2** To learn about the principles of energy management. **SO2.3**Toknow about energy policies and energy action plan. **SO2.4**To understand the energy security and reliability. **SO2.5** To lean about the need of renewable energy resources and energy efficiency.		**Unit-2 Current energy scenario** **2.1** Current energy scenario: **2.2** Energy scenario India and World. **2.3** Tutorial-1 **2.4** Principles of Energy management **2.5** Energy policy **2.6** Energy action planning **2.7** Tutorials- 2 **2.8** Energy security and reliability **2.9** Energy and environment **2.10** Need of Renewable energy **2.11** Energy efficiency **2.12** Tutorial- 3	i. Current Energy scenario ii. Energy and environment.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Prepare the different energy resources chart.
ii. Energy policies and energy action plans.

b. Mini Project:

Different sources of Renewable energy.

c. Other Activities (Specify):

Studying different energy resources and impact on environment

79EV201.3: Studying the different Non-Renewable resources of energy.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)
SO3.1know the different non renewable resources of energy(Fossil fuels) **SO3.2**understand composition of non renewable resources of energy like coal, crude oil and natural gases. **SO3.3** Know the demand of various types of non renewable resources of energy. **SO3.4** To understand consumption of coal, crude oil and natural gas. **SO3.5** To		**Unit-3: Non-renewable Sources of Energy** **3.1** Non-renewable energy sources **3.2** **3.3** **3.4** of coal **3.5** of crude oil **3.6** of natural gas, **3.7** and demands of coal **3.8** and demands of crude oil **3.9** and demand of natural gas **3.10** **3.11** Environmental impacts of fossil fuel consumption **3.12**

understand the environmental impact of fossil fuel consumption.		

SW-3 Suggested Sessional Work (SW):

a. Assignments:
i. Different types of non-renewable resources of energy.
ii. Consumption and demand of crude oil, coal and natural gas.
iii. Fossil fuels.

b. Mini Project:
Study of environmental impact by using these non-renewable resources of energy

c. Other Activities (Specify):
Impact of fossil fuels on environment

79EV 201.4: Implement Energy storage technologies and Energy Auditing

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	1
Total	16

Session Out comes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Understanding the types of renewable resources of energy **SO4.2** principles of generation of hydroelectric power **SO4.3**know tidal power, ocean thermal energy conversion **SO4.4**wind energy, geothermal energy, solar collectors, photo voltaic,		**Unit-4: Renewable Sources of Energy** **4.1** Renewable energy resources. **4.2** Principles of generation of hydroelectric power. **4.3** Tutorial- 1 **4.4** Principles of generation of- tidal power Ocean Thermal Energy Conversion (OTEC), **4.5** Wind energy **4.6** Geothermal energy	Different types of renewable resources of energy.

solar pond. **SO4.5** understand impact of exploitation of solar, wind, hydro and ocean energy on large scale.		**4.7** Solar collectors **4.8** Photo voltaic **4.9** Solar Pond **4.10** Tutorial- 2 **4.11** Environmental implication of energy use **4.12** Impacts of large-scale exploitation of Solar, Wind, Hydro and ocean energy	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Write different resources of renewable resources of energy.

ii. Impact of exploitation of renewable resources of energy.

b. Mini Project:

i. Visit to places where different types of renewable resources of Energy are used in large scale.

d. Other Activities (Specify):

Power Point Presentation of different types of renewable resources of energy.

79EV201. **5:** Learn the techniques of energy conservation.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**

SO5.1 understand Energy efficiency **SO5.2**Benefits of energy efficiency. **SO5.3**Importance of energy **SO5.4** Energy audit: reports & its format **SO5.5** Learn various methods of energy conservation.		**Unit 5: Energy conservation** fficiency -1 tion ion importance 2 of energy efficiency. udits eport format conservation l- 3

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Energy efficiency and its importance

b. **Mini Project:**
Energy audit

c. **Other Activities (Specify):**
Energy conservations

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)

79EV 201.1: Understand the Energy and environment	12	05	3	2	22
79EV 201.2: Know Current energy scenario	12	06	2	2	22
79EV 201.3: Gain the knowledge of the various Non-renewable Sources of Energy	12	0	3	2	17
79EV 201.4: Renewable Sources of Energy	12	0	3	1	16
79EV 201.5: Understand the concept of Energy conservation	12	0	2	2	16
Total Hours	**60**	**11**	**13**	**09**	**93**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Introduction**	03	01	01	05
CO-2	**Current energy scenario**	02	06	02	10
CO-3	**Non-renewable Sources of Energy**	03	07	05	15
CO-4	**Renewable Sources of Energy**	-	10	05	15
CO-5	**Energy conservation**	03	02	-	05

Total	11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for energy and environment will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Industries
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, Whats App, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	An Introduction to Energy Sources:	Viswanathan B		2006
2	Solar Energy	Tiwari, G. N	Narosa Publishing, New Delhi	2005
3	Renewable Energy and Environment-A Policy Analysis for India	Ravindranath, N.H., Usha Rao, K., Natarajan, B. and Monga, P	Tata-Mc Graw Hill, New Delhi	
4	Non-conventional Energy Sources	Rai, G.D	Khanna Publishers	2011

5	Handbook on Energy Audit and Environment management	Abbi Y. A., Jain Shashank	TERI, New Delhi	2006
Reference books.				
6	Ecology, Environment and Resource Conservation	Singh, J.S., Singh S.P. and Gupta S. R	Anamaya Publishers, New Delhi	2006
7	Energy and the Environment	Fowler, J. M.	McGraw Hill	1984
8	Energy Science- Principle, Technologies, and Impacts	John Andrews and Nick Jelly	Oxford University Press, UK	2007
9	Energy System and Sustainability	Boyle, G., Bob Everett and J. Ramage	Oxford Univ. Press, New York.	2003
10	General Aspects of Energy Management and Energy Audit	Bureau of Energy Efficiency	Govt of India	
11	Pedagogical approach: Classroom lectures, tutorial assignment along with relevant case studies			
12	Evaluation criteria: [Assessment mechanism for learning outcomes: The three tests and tutorial assignments spread over the entire semester] Test 1: 20% [Module 1 & 2, after 5-6 weeks of teaching] Test 2: 20% [Module 3 & 4, after 12-13 weeks of teaching] Test 3: 40% [Module 1 to 6, end of semester] Tutorials: 20% [10 tutorial assignments spread over entire semester]			
7	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. **Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science**
2. **Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science**
3. **Mrs. Suman Patel, Assistant Professor Dept of Environmental Science**
4. **Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science**
5. **Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science**

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code:79EV201
Course Title: Energy & Environment

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental	Planning abilities	Problem analysis	Design/development	Modern tool usage	Leadership skills	Professional Identity	Environmental	Communication	The Environm	Environment and	Life-long learning	Proficiency in Environm	Application of Multidisciplinary	Critical Thinking and Problem	Professional Ethics and Social
CO1: Describe Energy audits for building.	1	2	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2: Explain energy efficient lighting technologies and its application in commercial and residential sectors.	2	2	2	3	2	3	3	2	1	1	2	2	2	2	2	2
CO3: Describe Energy audits for building.	2	2	1	2	2	2	2	2	1	2	1	2	2	1	2	2

CO 4: Implement Energy storage technologies and Energy Auditing	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Learn the techniques of energy conservation.	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs &PSOs No.	Cos No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO-1: Describe Energy audits for building.**	SO1.1SO1.2SO1.3SO1.4 SO1.5	1.1, 1.2, 1.3, 1.4, 1.5	Unit-1. **Introduction** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 2: Explain energy efficient lighting technologies and its application in commercial and residential sectors.**	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1, 2.2, 2.3, 2.4, 2.5, 2.6	Unit-2 **Current energy scenario** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.12	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3: Describe Energy audits for building.**	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: Non-**renewable Sources of Energy** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4: Implement Energy storage technologies and Energy Auditing**	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: Renewable **Sources of Energy** 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11, 4.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5: Learn the techniques of energy conservation.**	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **Energy conservation** 5.1,5.2,5.3,5.4,5.5,5.6, 5.7,5.8,5.9,5.10, 5.11, 5.12	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: 79EV202

Course Title: Waste Management

Pre-requisite: Student should have basic knowledge of solid waste generation; composition & characterization, waste analyze and waste recycling.

Rationale: The students studying waste management will analyze, its monitoring and control of pollution and waste management guidelines.

Course Outcomes:

79EV 202.1: Describe solid waste generation, composition and characterization.
79EV202.2: Analyse waste recycling, 3R technology and fly ash management system
79EV203.3: Understand the landfill design.

79EV204.4: Discuss monitoring and control of radiation pollution.

79EV205.5: Implement E-Waste management guidelines.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV202	Waste Management	3+1	0	1	1	6	4

Legend:
CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self earning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV202	Waste Management	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV202.1: Describe solid waste generation, composition and characterization.

Approximate Hours

Item	AppX Hrs.
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)

SO1.1 Understand the various types of waste. **SO1.2**Different forms of waste & composition. **SO1.3**Muncipal waste and its types. **SO1.4** Biomedical waste & types of E-waste. **SO1.5** understands environmental & health impacts of different types of waste. .		**Unit-1Fundamental** **1.1** Fundamental **1.2** Definition, sources of solid waste. **1.3** Different types of solid wastes, **1.4** Composition of types of various wastes. **1.5** Municipal waste **1.6** Hazardous waste **1.7** Tutorial-1 **1.8** Biomedical waste **1.9** E-waste **1.10** Environmental & health impacts of various wastes. **1.11** Tutorial- 2 **1.12** Brief introduction to different types of wastes and its impacts.	1. Sources of wastes from municipalities. **2.** Impacts of waste on environmen t and health.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Different sources of wastes in municipalities.

b. Mini Project:

Problems faced due to waste.

c. Other Activities (Specify):

Hazardous and e-waste.

79EV 202.2: Analyse waste recycling, 3R technology and fly ash management system.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2

Total	16

Session Out comes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 To understand integrated solid waste management. **SO2.2** To learn about the waste reduction at source **SO2.3** To know about collection techniques and transport. **SO2.4** To understand the landfilling methods and composting. **SO2.5** To lean about the energy produced from waste.		**Unit-2 Municipal Solid Waste Management** **2.1** Municipal solid waste **2.2** Integrated Solid waste Management **2.3** Tutorial- 1 **2.4** Waste reduction at source **2.3** Collection techniques **2.5** Methods of collection **2.6** Transport of solid waste **2.7** Tutorial- 2 **2.8** Landfill method **2.9** Landfill gas **2.10** Composting, vermi-composting biofertilizers **2.11** Energy from Waste-Incineration, Pyrolysis, Gasification. **2.12** Energy from Refuse derived fuels, Biogas.	i. Different methods of waste collection. ii. Composting, biofertilizers.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Prepare the different ways or methods of waste collection.
ii. Methods by which waste can be reduced at source level.

b. Mini Project:

Different methods of composting and preparation of biofertilizers.

c. Other Activities (Specify):

Studying different methods by which this waste can be used for producing energy.

79EV202.3: Understand the landfill design.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1know the physic-chemical, biological and thermal destruction caused by hazardous wastes. **SO3.2**understand the process of incineration, pyrolysis, wet air oxidation. **SO3.3** Know the secure process of landfill **SO3.4** To understand land farming. **SO3.5** To understand the guidelines of landfill for hazardous waste disposal.		**Unit-3: Hazardous Solid Waste Management** **3.1** Hazardous solid waste. **3.2** Physico- Chemical destruction of Hazardous Wastes **3.3** Tutorial- 1 **3.4** Biological destruction of Hazardous Wastes. **3.5** Thermal destruction of Hazardous Wastes. **3.6** Incineration **3.7** Pyrolysis **3.8** Wet Air Oxidation. **3.9** Secured Landfill **3.10** Land Farming **3.11** Guidelines for identification of landfill for Hazardous Waste Disposal. **3.12** Tutorial- 2	i. Destruction caused due to hazardous waste. ii. Different guidelines for hazardous waste disposal.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Different types of destruction caused due to hazardous waste.
ii. Incineration, pyrolysis and wet air oxidation.

iii. Methods for secure landfill.

b. Mini Project:

Study of different guidelines for hazardous waste disposal management.

c. Other Activities (Specify):

Impact of hazardous waste on environment and health.

79EV 202.4: Discuss monitoring and control of radiation pollution.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	1
Total	16

Session Out comes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Understanding the different types of guidelines for collection of biomedical wastes. **SO4.2** understanding different modes of storage and transportation of biomedical wastes **SO4.3**know different types of containers for collecting different types of biomedical wastes **SO4.4**To know incineration method for biohazard wastes. **SO4.5** understand biohazard & cytotoxic hazard symbol	.	**Unit-4: Biomedical Waste Management** **4.1** Biomedical waste management. **4.2** Biomedical Waste Management **4.3** Guidelines for collection. **4.4** Tutorial- 1 **4.5** Storage of biomedical wastes. **4.6** Transportation of biomedical wastes. **4.7** Different containers & labeling **4.8** Tutorial- 2 **4.9** Incineration of biohazard wastes. **4.10** Tutorial- 3 **4.11** Biohazard symbol **4.12** Cytotoxic hazard symbol.	Guidelines for collection of biomedical waste.

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Storage & transportation techniques for biomedical wastes.
ii. Cytotoxic hazard symbols.

b. Mini Project:

i. Visit to places like hospital and nursing homes to identify different types of biomedical wastes.

d. Other Activities (Specify):

Power Point Presentation of different types Techniques and symbols used for biomedical wastes.

79EV202. 5: Learn about E- waste management.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Understand E- waste **SO5.2**Collection and storage of e-waste. **SO5.3**Segregation of e-waste **SO5.4** Understand amount of e-waste in whole world **SO5.5** Learn e-waste global trade issues & its management.		**Unit 5: E-waste Management** **5.1** -waste definition **5.2** E-Waste sources. **5.3** E-waste management **5.4** Tutorial- 1 **5.5** Collection of E-waste **5.6** Storage of e-waste **5.7** Segregation of e-waste **5.8** Tutorial- 2 **5.9** Amount of e-waste world wide **5.10** Tutorial- 2 **5.11** Global trade issue **5.12** Management of E-waste.	1.Collection of e-waste. 2.Segregation of e-waste

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Amount of e-waste worldwide.

b. **Mini Project:**
Global issue due to E-waste

c. **Other Activities (Specify):**
E-Waste management Process.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV 202.1: To understand solid waste generation, composition and characterization	12	0	3	2	17
79EV 202.2: Analyse waste recycling, 3R technology and fly ash management system.	12	0	2	2	16
79EV 202.3: Understand the landfill design	12	0	3	2	17
79EV 202.4: Discuss monitoring and control of radiation pollution	12	0	3	1	16
79EV 202.5: Implement E-Waste management guidelines.	12	0	2	2	16
Total Hours	**60**	**0**	**13**	**09**	**82**

Suggestion for End Semester Assessment
Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Municipal Solid Waste Management**	02	06	02	10
CO-3	**Hazardous Solid Waste Management**	03	07	05	15
CO-4	**Biomedical Waste Management**	-	10	05	15

CO-5	**E-waste Management**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for energy and environment will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Industries
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, What's App, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Environmental engineering:	G.N. Pandey, G.C. Carney	Tata McGraw Hill Education Pvt Ltd, New Delhi	
2	Environmental engineering	Howard S. Peavy, Donal R. Rowe, George Tchobanoglous	McGraw Hill Education Pvt Ltd, New Delhi.	
3	Solid waste pollution	Dr.Aradhana Salpekar	Jnanada Prakashan, New Delhi,	2008
4	Environmental Pollution Control Engineering	C. S. Rao,	New age International, Mumbai,	2003
5	Environmental Science Principles and Practices	R. C. Das, D. K. Behra	Printice, Hall, New Delhi,	2008

Reference Books:				
6	Hospital Waste Management	Acharya, D.B. and Singh, M	Minerva Press, Delhi	2003
7	Industrial Waste:	Alleman, J. E. and Karanagh, J. T	Ann Arbor Science	1982
8	Solid and Hazardous Waste Management	Bhatia, S.C	Atlantic Publishers	2007
9	Bio-waste and Biological Waste Treatment	Evans, G. James and James	(Science Publishers) Ltd, U.K.	2005
10	Pedagogical approach: Classroom lectures, tutorial assignment along with relevant case studies			
11	Evaluation criteria: [Assessment mechanism for learning outcomes: The three tests and tutorial assignments spread over the entire semester] Test 1: 20% [Module 1 & 2, after 5-6 weeks of teaching] Test 2: 20% [Module 3 & 4, after 12-13 weeks of teaching] Test 3: 40% [Module 1 to 6, end of semester] Tutorials: 20% [10 tutorial assignments spread over entire semester]			
12	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV202
Course Title: Waste Management

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for problems	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Describe solid waste generation, composition and characterization.	2	2	3	3	3	2	3	2	2	2	3	3	3	3	3	2
CO 2: Analyse waste recycling, 3R technology and fly ash management system.	2	3	2	2	2	2	3	2	2	2	2	2	2	2	2	2

CO3: Understand the landfill design	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO 4: Discuss monitoring and control of radiation pollution.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Implement E-Waste management guidelines.	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO-1: Describe solid waste generation, composition and characterization.**	SO1.1SO1.2SO1.3SO1.4 SO1.5	1.1,1.2,1.3,1.4	Unit-1. **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11, 1.12	
PO1,2,3,4,5,67,8,9,10,11,12	**CO 2: Analyse waste recycling, 3R technology and fly ash management system.**	SO2.1SO2.2SO2.3SO2.4, SO2.5	2.1,2.2,2.3,2.4,2.52.6, 2.7, 2.8	Unit-2 **Municipal Solid Waste Management** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11, 2.12	

PSO 1,2, 3, 4					
PO1,2,3,4,5,67,8,9,10,11,12 PSO 1,2, 3, 4	**CO3: Understand the landfill design**	SO3.1SO3.2, SO3.3SO3.4, SO3.5		Unit-3: **Hazardous Solid Waste Management** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12	
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4: Discuss monitoring and control of radiation pollution.**	SO4.1SO4.2SO4.3SO4.4, SO4.5		Unit-4: **Biomedical Waste Management** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11, 4.12	As mentioned in page number
PO1,2,3,4,5,6,7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5: Implement E-Waste management guidelines.**	SO5.1SO5.2SO5.3SO5.4, SO5.5		Unit 5: **E-waste Management** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: 79EV203

Course Title: Environmental Instrumentation and Analytical Techniques

Pre-requisite: This paper is very helpful for the students & an essential tool for research works as it comprises detail working principle of various instruments those are the base of practical work, analysis of various samples & finding results.

Rationale: The students studying the instruments and analytical techniques to sample different environmental components and implement advance technology.

Course Outcomes:

79EV 203.1: Know basic principle of different instruments.

79EV203.2: Apply sampling and analysis techniques of air and water quality.

79EV203.3: Learn applications of spectrophotometry, titrimetry etc.

79EV203.4: Use techniques of chromatography.

79EV203.5: Implement advance technologies like electrophoresis, autoradiography, ultracentrifugation etc.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV203	Environmental Instrumentation and Analytical Techniques	3+1	0	1	1	6	4

Legend:

CI: Classroom Instruction Includes different instructional strategies i.e., Lecture(L)and Tutorial (T)and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self earning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						**End Semester Assessment (ESA)**	**Total Marks** (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV203	Environmental Instrumentation and Analytical Techniques	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the

course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV203.1: Know basic principle of different instruments.

Approximate Hours

Item	AppX Hrs.
Cl	13
LI	0
SW	3
SL	2
Total	18

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Understand the techniques of soil sampling. **SO1.2**Different types of preservation, storage and processing techniques. **SO1.3** understand basic principles of auto clave, hot air oven. **SO1.4** Understand microbial isolation techniques **SO1.5** understands principal and application of trtrimetry, gravimetry, potentiometry, spectrophotometry analysis and their application. .		**Unit-1 Fundamental** **1.1** Soil sampling techniques **1.2** Preservation of soil sample. **1.3** Storage of soil sample. **1.4** Processing techniques of soil sample. **1.5** Basic principle of auto clave hot air oven. **1.6** Microbial isolation techniques. **1.7** Tutorial- 1 **1.8** Principals and application of titrimetry analysis and their application. **1.9** Principals and application of potentiometry analysis and their	1. Different techniques of soil sampling. **2.** Basic principles of different instruments.

		application. **1.10** Principals and application of spectrophotometry analysis and their application. **1.11** Tutorial- 2 **1.12** Brief introduction to different types of instruments used for environmental monitoring.	

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
Basic techniques of preservation, storage and processing techniques.

b. **Mini Project:**
Basic principles of auto clave, hot air oven.

c. **Other Activities (Specify):**
Basic introduction to different types of instruments used for environmental monitoring.

79EV 203.2: Apply sampling and analysis techniques of air and water quality.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	2
SL	2
Total	18

Session Out comes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO2.1 To understands techniques of air and water sampling. **SO2.2** To learn about the storage, processing and analysis techniques. **SO2.3** To know about principles of electrophoresis. **SO2.4** To understand the techniques of different instruments and their application **SO2.5** To lean about the radio activity detection techniques and application.		**Unit-2 Sampling and analysis** **2.1** Techniques of air quality sampling. **2.2** Techniques of air storage. **2.3** Techniques of air processing. **2.4** Techniques of air analysis. **2.5** Techniques of water quality sampling. **2.6** Techniques of water storage. **2.7** Techniques of water processing. **2.8** Techniques of water analysis. **2.9** Tutorial- 1 **2.10** Principals of chromatography analysis. **2.11** Application of chromatography. **2.12** Principals of gel electrophoresis techniques. **2.13** Application of gel electrophoresis. **2.14** Radio activity detection techniques and application: an overview.	i. Study different techniques of sampling. ii. Principles of chromatography.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Study the principles of gel electrophoresis techniques.
ii. Study the principles of radio activity detection techniques.

b. Mini Project:

Study the principles of chromatography.

c. Other Activities (Specify):

Study different techniques of sampling and analysis.

79EV203.3: Learn applications of spectrophotometry, titrimetry etc.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1know the application of various instruments. **SO3.2**understand the process of using different types of instruments. **SO3.3** Know the secure process of Spectrophotometry (UV). **SO3.4** To understand the titrimetry, gravimetry, colourimetry, NMR, ESR, Microscopy phase, light and flourscence microscopes.		**Unit-3: 3Instrumental Techniques** **3.1** Application of Spectro-photometry. **3.2** Application of UV-Visible spectro-photometry. **3.3** Tutorial-1 **3.4** Application of Titrimetry **3.5** Application of Gravimetry **3.6** Application of Colourimetry. **3.7** Application of Nuclear Magnetic Resonance (NMR) **3.8** Application of ESR, Microscopy-phase. **3.9** Application of light and flourscence microscopes **3.10** Scanning and Transmission electron microscopes. **3.11** Tutorial- 2	i. Study the application of different types of instruments. ii. Study the role of different types of microscopes in different types of fields.

SO3.5 To understand the guidelines of scanning and transmission electron microscopes.			

SW-3 Suggested Sessional Work (SW):

a. Assignments:
i. Study application of different types of instruments used for different types of purposes.
ii. Principles of different types microscopes.
iii. Study basic principles of different types of instruments.

b. Mini Project:
Study the different techniques and purposes of different types of instruments.

c. Other Activities (Specify):
Study the basic details, precautions and limitations of different types of instruments.

79EV 203.4: Learn applications of spectrophotometry, titrimetry etc.

Approximate Hours

Item	AppX Hrs
Cl	10
LI	0
SW	3
SL	1
Total	14

Session Out comes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Understanding the process and method of paper chromatography. **SO4.2** understanding process and method of thin layer chromatography. **SO4.3**Understanding the process and method of ion exchange theory.		**Unit-4: Chromatographic Techniques** **4.1** Introduction **4.2** Paper chromatography **4.3** Tutorial- 1 **4.4** Thin layer chromatography **4.5** Ion exchange chromatography **4.6** Tutorial- 2 **4.7** Column	Guidelines for using performing different types of chromatography.

SO4.4 Understanding the process and method of column chromatography. **SO4.5** Understanding the process and method of atomic absorption and spectrophotometry.		chromatography **4.8** Atomic Absorption **4.9** Tutorial- 3 **4.10** Spectrophotometry.	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Study the role of different types of Chromatography.

ii. Study the role of atomic absorption.

Mini Project:

i. Knowing the role of Spectrophotometry.

79EV203. **5**: **Studying different types of Advanced Technology**

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO5.1 understand Electrophoresis. **SO5.2**Understand solid and liquids scintillation. **SO5.3** Understand X-ray florescence, X-ray diffraction. **SO5.4** Understand Flame photomtery, Gas-liquid chromatography **SO5.5** Understand High pressure liquid chromatography-autor adiography		**Unit 5: Advanced Technology** **5.1** Electrophoresis **5.2** Solid scintillation. **5.3** Liquids scintillation **5.4** Tutorial- 1 **5.5** X-ray florescence **5.6** X-ray diffraction. **5.7** Flame photometry **5.8** Tutorial- 2 **5.9** Gas-liquid chromatography **5.10** Liquid chromatography **5.11** Tutorial- 3 High pressure liquid **5.12** chromatography-adiography	1. Principles of different advanced technology. 2. Basic of different instruments.

SW-5 Suggested Sessional Work (SW):

a. Assignments:
Study Principles of electrophoresis.

b. Mini Project:

Study principles and techniques of X- ray florescence.

c. Other Activities (Specify):
Study application of these instruments.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV 203.1: Know basic principle of different instruments.	13	0	3	2	18
79EV 203.2: Apply sampling and analysis techniques of air and water quality.	14	0	2	2	18
79EV 203.3: Learn applications of spectro-photometry, titrimetry etc.	11	0	3	2	16

79EV 203.4: Use techniques of chromatography.	10	0	3	1	14
79EV 203.5: Implement advance technologies like electrophoresis, autoradiography, ultracentrifugation etc.	12	0	2	2	16
Total Hours	**60**	**0**	**13**	**09**	**82**

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Sampling and analysis**	02	06	02	10
CO-3	**Instrumental Techniques**	03	07	05	15
CO-4	**Chromatographic Techniques**	-	10	05	15
CO-5	**Advanced Technology**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for energy and environment will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Industries
7. Demonstration

8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, Whats App, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Chemical & Biological Methods for Water Pollution Studies	R.K.Trivedy and P.K.Goel	Environmental Publications, Karad.	
2	Handbook of Methods in Environmental Studies: Vol.1&2	S.K.Maiti	ABD Publishers,Jaipur	
3	Practical Methods in Ecology and Environmental Science	R.K.Trivedy and P.K.Goel	Enviro Media,Karad	
4	Guidelines for the Examination of Water and Waste waters	CPCB, Delhi,India		
Reference Books:				
5	Physico chemical examination of water sewage and industrial effluents	Manivasakam, N.	Pragati prakasan, Meerut	
6	Environment, water and soil analysis:	Trivedi, P.R. and Raj Gurdeep.	Akashdeep Pub, New Delhi	
7	Manual of Microbiology-Tools and Techniques	Kanika Sharma	Ane Books India	2008
8	Microbiology A Laborotory Hand Book3	Cappucino, J.G. and Sherman.N.		
9	Pedagogical approach: Classroom lectures, tutorial assignment along with relevant case studies			
10	Evaluation criteria: [Assessment mechanism for learning outcomes: The three tests and tutorial assignments spread over the entire semester]			

	Test 1: 20% [Module 1 & 2, after 5-6 weeks of teaching] Test 2: 20% [Module 3 & 4, after 12-13 weeks of teaching] Test 3: 40% [Module 1 to 6, end of semester] Tutorials: 20% [10 tutorial assignments spread over entire semester]
11	Lecture note provided by Dept. of Environmental science, AKS University, Satna.

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV203

Course Title: Environmental Instrumentation and Analytical Techniques

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for problems	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills .	Professional Ethics and Social Responsibility
CO1: Know basic principle of different instruments.	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2
CO 2: Apply sampling and analysis techniques	2	2	3	2	2	2	3	2	2	2	3	2	2	2	2	3

of air and water quality.																
CO3: Learn applications of spectrophotometry, titrimetry etc.	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
CO 4: Use techniques of chromatography.	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Implement advance technologies like electrophoresis, autoradiography, ultracentrifugation etc.	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12	**CO-1: Know basic principle of different instruments.**	SO1.1SO1.2SO1.3SO1.4 SO1.5	1.1,1.2,1.3,1.4	Unit-1. **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12,1.13	

PSO 1,2, 3, 4					
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: **Apply sampling and analysis techniques of air and water quality.**	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3,2.4	Unit-2 **Sampling and analysis** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.12, 2.13,2.14	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3: Learn applications of spectrophotometry, titrimetry etc.**	SO3.1SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3.3,3.4	Unit-3: **Instrumental Techniques** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4: Use techniques of chromatography.**	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Chromatographic Techniques** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5: Implement advance technologies like electrophoresis, autoradiography, ultracentrifugation etc.**	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **Advanced Technology** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: 79EV204

Course Title: Remote Sensing and Geo-informatics

Pre-requisite: Student should have basic knowledge of basic principles of Remote sensing and Geo-informatics. This paper introduces various methods used in the collection of data and analysis for environmental studies. Remote sensing is increasingly being used in investigating resources, disasters and many more various factors. The students will be benefited in learning & applying various techniques of remote sensing and GIS in different aspects of environmental studies.

Rationale: The students studying Remote sensing and geo-informatics will able to apply the use of these applications.

Course Outcomes:

79EV 204.1: Explain about Remote Sensing, Geographical Information System and Global Positioning System.

79EV204.2: Outline and interpret the elements of aerial photographs.

79EV204.3: Describe principles and applications of thermal and microwave remote sensing.

79EV204.4: Differentiate GIS and science of map making, non-spatial versus spatial data.

79EV204.5: Apply Remote Sensing & GIS Applications.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV204	Remote Sensing and Geo-informatics	4	0	1	1	6	4

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self earning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ESA)
PCC	79EV204	Remote Sensing and Geo-informatics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV204.1: Explain about Remote Sensing, Geographical Information System and Global Positioning System.

Approximate Hours

Item	AppX Hrs.
Cl	14
LI	0
SW	3
SL	2
Total	19

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO1.1 Understand the fundamentals of Remote sensing and GIS. **SO1.2** Understand the principles of aerial photography and satellite remote sensing. **SO1.3** understands basic principles of Electromagnetic spectrum. **SO1.4** Understand remote sensing platforms, sensors and spectra of environmental components. **SO1.5** understands principal and application of truth data collection, GPS technology and navigation. .		**Unit-1 Fundamentals** **1.1** Fundamentals of Remote sensing **1.2** Fundamentals of GIS **1.3** Principles of aerial photography. **1.4** Principles of satellite remote sensing **1.5** Tutorial-1 **1.6**Electromagnetic spectrum (EMS), **1.7** RS Platforms **1.8** Sensors, **1.9** Spectra of Environmental components. **1.10** Ground truth data collection. **1.11** Tutorial- 2 **1.12** GPS Technology **1.13** Navigation. **1.14** Tutorial- 3	1. Fundamentals of remote sensing and GIS. **2.** Basic principles of GPS technology and navigation.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Basic principles of aerial photography.

b. Mini Project:

Basic principles of GPS technology.

c. Other Activities (Specify):

Basic fundamentals of GIS and remote sensing.

79EV 204.2: Outline and interpret the elements of aerial photographs.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	2
Total	17

Session Out comes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 To understands techniques of photography. **SO2.2** To learn about the orbits (sun synchronous, geo synchronous, polar) **SO2.3**To know about principles & applications of CCD cameras, image analysis, aerial photographic interpretation. **SO2.4**To understand the techniques of stereoscopic data analysis and series of satellites. **SO2.5** To lean about the future aspects of remote sensing in India.		**Unit-2 Date acquisition** **2.1** Aerial photography. **2.2** Orbits (sun synchronous) **2.3** Orbits (geo synchronous) **2.4** Orbits (Polar) **2.5** Tutorial -1 **2.6** Multi spectral scanners **2.7** CCD cameras **2.8** Imager analysis **2.9** Elements of aerial photographic interpretation. **2.10** Stereoscopic data analysis **2.11** Series of satellites **2.12** Tutorial- 2 **2.13** Future prospects of remote sensing in India.	i. Study principles and basics of photography. ii. Study future prospects of remote sensing.

SW-2 Suggested Sessional Work (SW):

a. Assignments:
i. Study the basics of orbits.
ii. Study the principles of CCD camera,

b. Mini Project:
Study the principles of multi spectral scanners.

c. Other Activities (Specify):
Study basics of stereoscopic data analysis and series of satellites.

79EV204.3: Describe principles and applications of thermal and microwave remote sensing.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1know the characteristics of titrimerty, gravimetry and colourimetry. **SO3.2**understand the process of preprocessing, image classification. **SO3.3** understanding all different types of GIS principles and changes of detection. **SO3.4** To understand the raster and vector GIS, Data-input, data base creations and data storage.		**Unit-3: Satellite Image Analysis & Photo-grammetry** **3.1** image characteristics Titrimetry **3.2** image characteristics Gravimetry **3.3** image characteristics Colorimetriy **3.4** Tutorial-1 **3.5** image classification reprocessing, (supervised) **3.6** Preprocessing, image classification (unsupervised) **3.7** Change detections. **3.8** Principles of GIS **3.9** Tutorial- 2 **3.10** Raster and vector GIS. **3.11**Data input, database creation, data storage **3.12** Data base standards,	i. Study the principles of different satellite image analysis. ii. Study the basics and principles of GIS, raster and vector GIS.

SO3.5 To understand the guidelines base standards, processing and their manipulation.		processing and manipulation.	

SW-3 Suggested Sessional Work (SW):

a. Assignments:
i. Study characters of Titrimetry, Gravimetry and Glavimetry.
ii. Study Principles of data input, database creation and data storage.
iii. Study basic principles of different types of instruments.

b. Mini Project:
Study basic principles of database standards its processing and manipulation.

c. Other Activities (Specify):
Visit to places or labs where practical demonstration can be seen.

79EV 204.4: Differentiate GIS and science of map making, non-spatial versus spatial data.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	1
Total	15

Session Out comes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Understanding the basic concepts & technology of GIS. **SO4.2** understanding process and method of raster and vector data. **SO4.3**Understanding the process and method of	.	**Unit-4: GIS & GPS** **4.1** Basic concepts & technology of GIS. **4.2** Raster data **4.3** Vector data **4.4** Tutorial-1 **4.5** Map projection **4.6** Topology creation	Study of basic of GIS and GPS with its use for environmental studies.

map projection, its topology creations and their analysis. **SO4.4**Understanding the process and method of using Global Positioning system (GPS). **SO4.5** Understanding the process and method of GPS & GIS technology for environmental studies.		**4.7** Overlay analysis. **4.8** Global Positioning System (GPS): Basic principles. **4.9** Tutorial- 2 **4.10** Applications to environmental studies **4.11** Tutorial- 3	

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Study the basic principles & use of GIS and GPS.

ii. Study the role of GIS and GPS for the Environmental Studies.

b. Mini Project:

i. Practical demonstration of different environmental factors by using GIS & GPS technology.

79EV204. 5: Apply Remote Sensing & GIS Applications.

Approximate Hours

Item	AppX Hrs
Cl	10
LI	0
SW	3
SL	2
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO5.1 understand Electrophoresis. **SO5.2**Understand solid and liquids cintillation. **SO5.3** Understand X-ray florescence, X-ray diffraction. **SO5.4** Understand Flame photomtery, Gas-liquid chromatography **SO5.5** Understand High pressure liquid chromatography-auto radiography		**Unit 5: Remote Sensing & GIS Applications** **5.1** Remote sensing. **5.2** GIS application in Forestry **5.3** Environmental degradation. **5.4** Tutorial- 1 **5.5** Agriculture: Soil survey. **5.6** Soil mapping. **5.7** Tutorial- 2 **5.8** Decision Support System for Disaster Management **5.9** Tutorial- 3 **5.10** water quality mapping.	1. Principles of Remote sensing. 2. Basic of GIS applications.

SW-5 Suggested Sessional Work (SW):

a. Assignments:
Study the role of remote sensing & GIS applications in different fields.

b. Mini Project:
Study basic principles and techniques of soil survey and soil mapping.

c. Other Activities (Specify):
Study the role of GIS and remote sensing for disaster management.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV204.1: Knowledge of different types of instruments used for Environmental monitoring.	14	0	3	2	19

79EV 204.2: Outline and interpret the elements of aerial photographs. (Date acquisition)	13	0	2	2	17
79EV204.3: Knowledge of principles and applications of thermal and microwave remote sensing. Satellite Image Analysis & Photo-grammetry	12	0	3	2	17
79EV 204.4: Knowledge of GIS and science of map making, non-spatial versus spatial data. (GIS & GPS)	11	0	3	1	15
79EV204. 5: Knowledge of using Remote Sensing & GIS Applications in environmental Science.	10	0	3	2	15
Total Hours	**60**	**0**	**14**	**09**	**83**

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamentals**	03	01	01	05
CO-2	**Date acquisition**	02	06	02	10
CO-3	**Satellite Image Analysis & Photogrammetry**	03	07	05	15
CO-4	**GIS & GPS**	-	10	05	15
CO-5	**Remote Sensing & GIS Applications**	03	02	-	05
Total		**11**	**26**	**13**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for energy and environment will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Industries
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Face book, Twitter, What's App, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Fundamentals of Remote Sensing	George Joseph	Universities Press Hyderabad.	2005
2	Remote Sensing and GIS	M. Anji Reddy	BS Publications, Hyderabad	2008
3	GIS Basics	Shahab Fazal	New Age International Publishers, New Delhi	2008
4	Geographical Information Systems	Anil K.Jamwal	Jnanda Prakashan, NewDelhi.	2008
Reference Books:				
5	Remote Sensing of the Environment- An earth resource perspective	J. R. Jensen	Pearson Education	
6	An Introduction to GIS	Heywood	Pearson	
7	Essentials of GPS	N. K. Agarwal	Spatial Networks Pvt. Ltd., Hyderabad	2004

8	Principles of Geographical Information System for Land Resource Assessment	Burrough, P. A	Oxford Univ. Press	1986
9	Remote Sensing & Image Interpretation	Lillesand T.M. & Kiefer R. W		2nd Ed 1987
10	Pedagogical approach: Classroom lectures, tutorial assignment along with relevant case studies			
11	Evaluation criteria: [Assessment mechanism for learning outcomes: The three tests and tutorial assignments spread over the entire semester] Test 1: 20% [Module 1 & 2, after 5-6 weeks of teaching] Test 2: 20% [Module 3 & 4, after 12-13 weeks of teaching] Test 3: 40% [Module 1 to 6, end of semester] Tutorials: 20% [10 tutorial assignments spread over entire semester]			
12	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping
Programme Title: M.Sc. Environmental Science
Course Code: 79EV204
Course Title: Remote Sensing and Geo-informatics

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning	Problem analysis	Design/development of solution	Modern tool usage	Leadership	Professional Identity	Environmental Ethics	Communication	The Environment	Environment and	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Explain about Remote Sensing, Geographical Information System and Global Positioning System.	2	2	3	3	3	3	3	2	2	2	3	2	2	3	3	2
CO 2: Outline and interpret the elements of aerial photographs.	2	3	2	2	2	2	3	2	2	1	2	2	2	2	2	1

CO3: Describe principles and applications of thermal and microwave remote sensing.	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 4: Differentiate GIS and science of map making, non-spatial versus spatial data.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Apply Remote Sensing & GIS Applications.	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO-1: Explain about Remote Sensing, Geographical Information System and Global Positioning System.**	SO1.1S O1.2S O1.3S O1.4 SO1.5	1.1,1.2,1.3,1.4	Unit-1. **Fundamentals** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12 , 1.13, 1.14	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 2: Outline and interpret the elements of aerial photographs.**	SO2.1S O2.2S O2.3 SO2.4 SO2.5	2.1,2.2,2.3	Unit-2 **Date acquisition** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11, 2.12, 2.13	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO3: Describe principles and applications of thermal and microwave remote sensing.**	SO3.1S O3.2 SO3.3 SO3.4 SO3.5		Unit-3: Satellite **Image Analysis & Photogrammetry** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 4: Differentiate GIS and science of map making, non-spatial versus spatial data.**	SO4.1S O4.2S O4.3S O4.4 SO4.5	4.1,4.2,4.3	Unit-4: GIS **& GPS** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	**CO 5: Apply Remote Sensing & GIS Applications.**	SO5.1S O5.2S O5.3S O5.4 SO5.5		Unit 5: **Remote Sensing & GIS Applications** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10	

Semester-II

Course Code: **79EV251**

Course Title: Practical Lab-1

Pre- requisite: Student should have basic knowledge of various renewable energy resources and waste management processes.

Rationale: The M.Sc. Environmental Science program incorporates a range of practical experiences designed to provide students with hands-on knowledge and skills essential for addressing contemporary environmental challenges. Visits to cogeneration or waste heat recovery plants and landfills offer insights into sustainable energy practices and waste management, while exercises such as the electrical tariff calculations and understanding photovoltaic cells emphasize the economic and technical aspects of renewable energy. Conducting an energy audit of AKS University encourages the application of theoretical knowledge to real-world scenarios, promoting sustainability on campus. The analysis of municipal solid waste, including determining moisture content, pH, NPK, and C/N ratio, equips students with critical laboratory skills and an understanding of waste composition and its environmental impact. Collectively, these practical foster a comprehensive understanding of environmental systems, sustainability practices, and analytical techniques, preparing students to become adept environmental scientists capable of making informed, impactful decisions.

Course Outcomes:

79EV251.1: Evaluate the environmental and economic impacts of cogeneration and waste heat recovery.
79EV251.2: Analyze the efficiency and performance parameters of PV cells.
79EV251.3: Develop skills in waste management and material recovery.
79EV251.4: Understand the role of NPK in composting and soil amendment.
79EV251.5: Compare different waste disposal and treatment methods.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Laboratory course (PLC)	**79EV251**	Practical Lab-1	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV+ +TA)		
PLC	79EV251	Practical Lab-1	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV251.1: Evaluate the environmental and economic impacts of cogeneration and waste heat recovery.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Gain a comprehensive understanding of the basic principles of cogeneration **SO1.2** Analyze the efficiency metrics of the plant, including energy conversion efficiency, heat recovery rates, and overall system performance, and compare them with industry standards. **SO1.3** Learn how to calculate the different components of an electricity bill. **SO1.4** Analyze the impact of different tariff structures on various types of consumers **SO1.**5 Application of Theoretical Knowledge.	**Unit-1** 1.1 Visit to cogeneration or waste heat recovery plant and submit a report. – 1 1.2 Visit to cogeneration or waste heat recovery plant and submit a report. – 2 1.3 Visit to cogeneration or waste heat recovery plant and submit a report. – 3 1.4 Visit to cogeneration or waste heat recovery plant and submit a report. – 4 1.5 Study the electrical tariff calculations – 1 1.6 Study the electrical tariff calculations – 2 1.7 Study the electrical tariff calculations – 3 1.8 Study the electrical tariff calculations – 4 1.9 Study the electrical tariff calculations – 5		1.What is Heat recovery?

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Develop strategies for optimizing electricity consumption and reducing costs based on tariff analysis, including demand-side management techniques and energy efficiency measures.

b. Mini Project:

Prepare a detailed report on the visit, documenting the observations, data collected, and insights gained, and provide recommendations for potential improvements in plant operation and efficiency.

c. Other Activities (Specify):

Evaluate the regulatory framework governing electricity tariffs in your region, including the roles of utility companies, regulatory bodies, and consumer rights organizations.

79EV251.2: Analyze the efficiency and performance parameters of PV cells.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Understand the Basic Components. **SO2.2** Explain the Photovoltaic Effect. **SO2.3** Identify Energy Saving Opportunities. **SO2.4** Assess Energy Consumption. **SO2.**5 Analyze the Efficiency Factors.	**Unit-2** 2.1 Working principle of photovoltaic cell – 1 2.2 Working principle of photovoltaic cell – 2 2.3 Working principle of photovoltaic cell – 3 2.4 Working principle of photovoltaic cell – 4 2.5 Perform energy audit of AKS University and submit report with recommendation – 1 2.6 Perform energy audit of AKS University and submit report with		1.What is Energy Audit?

	recommendation – 2 2.7 Perform energy audit of AKS University and submit report with recommendation – 3 2.8 Perform energy audit of AKS University and submit report with recommendation – 4 2.9 Perform energy audit of AKS University and submit report with recommendation – 5		

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Identify and describe the key components of a photovoltaic cell, including the semiconductor materials, p-n junction, and electrodes.

b. **Mini Project:**
Explain the photovoltaic effect, detailing how light energy is converted into electrical energy in a photovoltaic cell.

c. **Other Activities (Specify):**
Conduct a comprehensive assessment of energy consumption in various buildings and facilities within AKS University.

79EV251.3: Develop skills in waste management and material recovery.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Identify Major Waste Categories.	**Unit-3** 3.1 Study of composition of		1. What is solid waste?

SO3.2 Quantitative Analysis. **SO3.3** Analyze the composition of organic waste. **SO3.4** Assess Recyclable Materials. **SO3.**5 compare different methods for moisture determination.	Municipal Solid Waste – 1 3.2 Study of composition of Municipal Solid Waste – 2 3.3 Study of composition of Municipal Solid Waste – 3 3.4 Study of composition of Municipal Solid Waste – 4 3.5 Study of composition of Municipal Solid Waste – 5 3.6 To determine the moisture content in given solid waste sample – 1 3.7 To determine the moisture content in given solid waste sample – 2 3.8 To determine the moisture content in given solid waste sample – 3 3.9 To determine the moisture content in given solid waste sample – 4		

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
Write a report on impact of moisture content on waste handling, processing, and disposal methods.

b. **Mini Project:**
Compare different methods for moisture determination (e.g., oven drying, microwave drying) and evaluate their accuracy.

c. **Other Activities (Specify):**
Visit to waste dumping sites and collect the samples of solid waste

79EV251.4: Understand the role of NPK in composting and soil amendment.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	21

Total	12

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Hands-On Experience with pH Indicators. **SO4.2**. Proficiency in Using a pH, Meter. **SO4.3** Safety and Environmental Awareness. **SO4.4** Knowledge of NPK Components. **SO4.**5 Practical Application and Environmental Impact.	**Unit-4** 4.1 To determine the pH of a given sample of hazardous waste by universal indicator method and pH meter method – 1 4.2 To determine the pH of a given sample of hazardous waste by universal indicator method and pH meter method – 2 4.3 To determine the pH of a given sample of hazardous waste by universal indicator method and pH meter method – 3 4.4 To determine the pH of a given sample of hazardous waste by universal indicator method and pH meter method – 4 4.5 To determine NPK in solid waste material – 1 4.6 To determine NPK in solid waste material – 2 4.7 To determine NPK in solid waste material – 3 4.8 To determine NPK in solid waste material – 4 4.9 To determine NPK in solid waste material – 5		1. What is hazardous waste?

SW-4 Suggested Sessional Work (SW):

1. Assignments:

Describe the applications of determining NPK in solid waste, including its potential use in agriculture as a soil amendment, and the environmental impact of improper waste disposal.

2. Mini Project:

compare and analyze the results obtained from the universal indicator method and the pH meter method, understanding the advantages and limitations of each technique.

79EV251.5: Compare different waste disposal and treatment methods.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO5.1 Understanding the Importance of C/N Ratio. **SO5.2**. Apply analytical techniques **SO5.3** Gain skills in interpreting the results of C/N ratio analyses. **SO5.4** Observe and understand various waste management practices. **SO5.5** Learn the principles and methods of biological composting.	**Unit-5** 5.1 To determine C/N ratio in solid waste – 1 5.2 To determine C/N ratio in solid waste – 2 5.3 To determine C/N ratio in solid waste – 3 5.4 To determine C/N ratio in solid waste – 4 5.5 A visit to normal and secured landfill site, biological composting/vermicomposting – 1 5.6 A visit to normal and secured landfill site, biological composting/vermicomposting – 2 5.7 A visit to normal and secured landfill site, biological composting/vermicomposting – 3 5.8 A visit to normal and secured landfill site, biological composting/vermicomposting – 14 5.9 A visit to normal and secured landfill site, biological composting/vermicomposting – 5		1. Methods of waste disposal.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Compare and contrast the operational procedures, environmental impacts, and safety measures of normal and secured landfill sites.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV251.1: Evaluate the environmental and economic impacts of cogeneration and waste heat recovery.	0	18	2	1	21
79EV251.2: Analyze the efficiency and performance parameters of PV cells.	0	18	2	1	21
79EV251.3: Develop skills in waste management and material recovery.	0	18	2	1	21
79EV251.4: Understand the role of NPK in composting and soil amendment.	0	18	2	1	21
79EV251.5: Compare different waste disposal and treatment methods.	0	18	2	1	21
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10
CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Handbook of Environment and Waste Management	Yu Lawrence K Wangng-Tse Hung,	-	2020
2	The Complete Lab Manual for Renewable Energy	Cutter & Ammond	Delmar Cengage Learning	2015
3	Experiments on Energy, the Environment, and Sustainability	R. Mark Isaac Douglas A. Norton	Emerald Publishing Limited	2011
4	Handbook of Energy Transitions	Muhammad Asif	CRC Press	2022

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV251
Course Title: Practical Lab – 1

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Evaluate the environmental and economic impacts of cogeneration and waste heat recovery.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Analyze the efficiency and performance parameters of PV cells.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**
CO3: Develop skills in waste management and material recovery.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

CO 4: Understand the role of NPK in composting and soil amendment.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO 5 Compare different waste disposal and treatment methods.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Evaluate the environmental and economic impacts of cogeneration and waste heat recovery.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Analyze the efficiency and performance parameters of PV cells.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Develop skills in waste management and material recovery.	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4 Understand the role of NPK in composting and soil amendment.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Compare different waste disposal and treatment methods.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

Semester-II

Course Code: **79EV252**

Course Title: Practical Lab-2

Pre- requisite: Student should have basic knowledge of Remote sensing and GIS techniques.

Rationale: In an M.Sc. Environmental Science program, these experiments collectively aim to provide a comprehensive understanding of environmental monitoring and analysis. Particulate Matter (PM) Sampling and Analysis and Gravimetric Analysis of PM2.5 and PM10 help in assessing air quality by measuring airborne particulate pollutants. The study of Continuous Emission Monitoring Systems (CEMS) and Measurement of Stack Gases for pollutants like SO2, NOx, and CO is crucial for evaluating industrial emissions and their environmental impact. High-performance liquid chromatography (HPLC) and Extraction and Analysis of Heavy Metals using AAS focus on detecting and quantifying organic contaminants and heavy metals in water, respectively. Enumeration and identification of microbial contaminants in water using microbiological techniques are vital for water quality assessment. Measuring and analyzing noise pollution provides insights into its effects on different environments. MAP Reading, identification of signs and symbols, preparation of base maps, and GPS measurement of locations at AKSU campus are essential for spatial analysis and environmental management. Together, these experiments equip students with practical skills and knowledge for environmental monitoring and management.

Course Outcomes:

79EV252.1: Understand the techniques for sampling particulate matter from the air.
79EV252.2: Analyze continuous data for various pollutants and interpret emission trends.
79EV252.3: Use AAS to quantify the concentration of heavy metals.
79EV152.4: Use sound level meters and other instruments to measure noise pollution levels.
79EV152.5: Create base maps by interpreting and digitizing Survey of India topographic sheets.

Scheme of Studies:

Board of Study				Scheme of studies (Hours/Week)	Total Credits

	Course Code	Course Title	Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	(C)
Program Laboratory course (PLC)	**79EV252**	Practical Lab-2	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV+ +TA)		
PLC	79EV252	Practical Lab-2	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV252.1: Understand the techniques for sampling particulate matter from the air.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Understand Sampling Techniques. **SO1.2** Evaluate Air Quality Standards. **SO1.3** Understand Measurement Techniques. **SO1.4** Compare with Standards **SO1.5** Documentation of Sampling Process.	**Unit-1** 1.1 Particulate Matter (PM) Sampling and Analysis – 1 1.2 Particulate Matter (PM) Sampling and Analysis – 2 1.3 Particulate Matter (PM) Sampling and Analysis – 3 1.4 Particulate Matter (PM) Sampling and Analysis – 4 1.5 Gravimetric analysis of PM2.5 and PM10 – 1 1.6 Gravimetric analysis of PM2.5 and PM10 – 2 1.7 Gravimetric analysis of PM2.5 and PM10 – 3 1.8 Gravimetric analysis of PM2.5 and PM10 – 4 1.9 Gravimetric analysis of PM2.5 and PM10 – 5		1.What is Sampling? .

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Write the principles of gravimetric measurement and the importance of precision in determining PM2.5 and PM10 concentrations.

b. Mini Project:

Write the procedures for analyzing particulate matter samples, including sample collection, preservation, and preparation.

c. Other Activities (Specify):

Describe the use of high-volume samplers

79EV252.2: Analyze continuous data for various pollutants and interpret emission trends.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Understanding CEMS Operation. **SO2.2** Calibration and Maintenance of equipment. **SO2.3** Techniques for Gas Measurement. **SO2.4** Reporting and Documentation. **SO2.**5 Field Sampling Techniques.	**Unit-2** 2.1 Study of Continuous Emission Monitoring Systems (CEMS) – 1 2.2 Study of Continuous Emission Monitoring Systems (CEMS) – 2 2.3 Study of Continuous Emission Monitoring Systems (CEMS) – 3 2.4 Study of Continuous Emission Monitoring Systems (CEMS) – 4 2.5 Study of Continuous Emission Monitoring Systems (CEMS) – 5 2.6 Measurement of stack		1.Continuous Emission Monitoring Systems.

	gases for pollutants like SO2, NOx, and CO – 1 2.7 Measurement of stack gases for pollutants like SO2, NOx, and CO – 2 2.8 Measurement of stack gases for pollutants like SO2, NOx, and CO – 3 2.9 Measurement of stack gases for pollutants like SO2, NOx, and CO – 4		

SW-2 Suggested Sessional Work (SW):

a. Assignments:
Measuring concentrations of pollutants like SO2, NOx, and CO using various analytical techniques and instruments.

b. Mini Project:
Record noise level data, analyze it to understand the impact of different noise sources in each zone.

C. Other Activities (Specify):
Write the significance of the data in assessing industrial emissions and air quality.

79EV252.3: Use AAS to quantify the concentration of heavy metals.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Gain hands-on experience in setting up, operating, and maintaining HPLC equipment.	**Unit-3** 3.1 High-performance liquid chromatography (HPLC) for organic contaminants		1. What is HPLC?

SO3.2 Learn techniques for preparing water samples for HPLC analysis. **SO3.3** Understand the importance of avoiding contamination during sample collection. **SO3.4** Gain practical experience in operating Atomic Absorption Spectroscopy (AAS) equipment. **SO3.**5 Develop the ability to perform quantitative analysis of heavy metals using AAS.	in water – 1 3.2 High-performance liquid chromatography (HPLC) for organic contaminants in water – 2 3.3 High-performance liquid chromatography (HPLC) for organic contaminants in water – 3 3.4 High-performance liquid chromatography (HPLC) for organic contaminants in water – 4 3.5 Extraction and analysis of heavy metals using AAS – 1 3.6 Extraction and analysis of heavy metals using AAS – 2 3.7 Extraction and analysis of heavy metals using AAS – 3 3.8 Extraction and analysis of heavy metals using AAS – 4 3.9 Extraction and analysis of heavy metals using AAS – 5		

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Discuss regulatory limits for heavy metals and their implications for environmental management and public health.

b. Mini Project:

How to interpret the results and calculate the concentration of heavy metals in samples.

c. Other Activities (Specify):

Methods for collecting and preparing environmental samples (e.g., water, soil) for heavy metal analysis.

79EV252.4: Use sound level meters and other instruments to measure noise pollution levels.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Develop hands-on experience with microbiological techniques. **SO4.2**. Gain the ability to identify different types of microorganisms, including bacteria, viruses, and protozoa, present in water samples. **SO4.3** Acquire hands-on experience with sound level meters and other instruments used to measure noise pollution levels in various environments. **SO4.4** Develop skills in collecting, analyzing, and interpreting noise	**Unit-4** 4.1 Enumeration and identification of microbial contaminants in water samples using microbiological techniques-1 4.2 Enumeration and identification of microbial contaminants in water samples using microbiological techniques-2 4.3 Enumeration and identification of microbial contaminants in water samples using microbiological techniques-3		1. Sound Level meter.

data to identify sources and assess the impact of noise pollution. **SO4.** Develop the ability to propose and evaluate noise pollution mitigation strategies.	4.4 Enumeration and identification of microbial contaminants in water samples using microbiological techniques-4 4.5 To measure and analyze noise pollution in different environments-1 4.6 To measure and analyze noise pollution in different environments-2 4.7 To measure and analyze noise pollution in different environments-3 4.8 To measure and analyze noise pollution in different environments-4 4.9 To measure and analyze noise pollution in different environments-5		

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Describe noise pollution standards and regulations, and learn how to evaluate compliance with these standards.

b. **Mini Project:**
Identify sources and assess the impact of noise pollution.

79EV252.5: Create base maps by interpreting and digitizing Survey of India topographic sheets.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 Develop the ability to read and interpret different types of maps **SO5.2** Gain proficiency in recognizing and understanding the various symbols and signs used in maps. **SO5.3** Gain a thorough understanding of Survey of India topographic sheets. **SO5.4** Apply base maps for environmental planning, land use analysis, and resource management. **SO5.5** Gain hands-on experience and proficiency in using GPS devices for accurate measurement of geographic coordinates.	**Unit-5** 5.1 MAP Reading & Identification of signs & Symbols used in MAPS – 1 5.2 MAP Reading & Identification of signs & Symbols used in MAPS – 2 5.3 Preparation of Base map from Survey of India Top sheets - 1 5.4 Preparation of Base map from Survey of India Top sheets - 2 5.5 Latitude & longitude measurement of 10 spots at AKSU campus by GPS device – 1 5.6 Latitude & longitude measurement of 10 spots at AKSU campus by GPS device – 2 5.7 Latitude & longitude measurement of 10 spots at AKSU campus by GPS device – 3 5.8 Latitude & longitude measurement of 10 spots at AKSU campus by GPS device – 4 5.9 Latitude & longitude measurement of 10 spots at AKSU campus by GPS device – 5		1. What is Base MAP?

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Describe base maps for environmental planning, land use analysis, and resource management.

b. **Mini Project:**
Collecting and recording latitude and longitude data for multiple locations.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV252.1: Understand the techniques for sampling particulate matter from the air.	0	18	2	1	21
79EV252.2: Analyze continuous data for various pollutants and interpret emission trends.	0	18	2	1	21
79EV252.3: Use AAS to quantify the concentration of heavy metals.	0	18	2	1	21
79EV252.4: Use sound level meters and other instruments to measure noise pollution levels.	0	18	2	1	21
79EV252.5: Create base maps by interpreting and digitizing Survey of India topographic sheets.	0	18	2	1	21
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10

CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Handbook of Practicals in Remote Sensing GIS and GPS for Beginners	Dr. Anil Boro	EBH Publishers (India)	2021
2	Laboratory Manual	Department of Environmental Science & Engineering	IIT Dhanbad	
3	Air Pollution Sampling and Analysis	Dr Sharad Gokhale	Dept of Civil Engg IIT Guwahati, Asam	2009
4	Air Quality Monitoring, Measuring, and Modeling Environmental Hazards	Marco Ragazzi	Taylor and Francis Books Limited U.K.	2016

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV252
Course Title: Practical Lab – 2

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1 Understand the techniques for sampling particulate matter from the air.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2 Analyze continuous data for various pollutants and interpret emission trends.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**
CO3: Use AAS to quantify the concentration of heavy metals.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Use sound level meters and other instruments to measure noise pollution levels.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**

CO 5 Create base maps by interpreting and digitizing Survey of India topographic sheets.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Understand the techniques for sampling particulate matter from the air.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Analyze continuous data for various pollutants and interpret emission trends.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Use AAS to quantify the concentration of heavy metals.	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4 Use sound level meters and other instruments to measure noise pollution levels.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Create base maps by interpreting and digitizing Survey of India topographic sheets.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

Semester II

Course Code: **79EV253**

Course Title: **Industrial visit/Field work/ Educational tour**

Pre- requisite: Basic Knowledge of Energy & Environment, Waste Management, Remote Sensing & GIS and Instrumentation & Power Point Presentation.

Rationale: Fieldwork and industrial visits are crucial for M.Sc. Environmental Science students as they provide practical exposure to real-world environmental issues and solutions. These experiences allow students to apply theoretical knowledge, observe ecological processes firsthand, and understand the implementation of environmental policies and technologies. Additionally, they offer valuable opportunities for networking and gaining insights into potential career paths.

Course Outcomes:

79EV253.1: Apply theoretical concepts learned in the classroom to real-world environmental issues and scenarios.

79EV253.2: Develop improved analytical and observational skills by examining environmental processes and conducting on-site data collection and analysis.

79EV253.3: Gain insights into various industrial processes and their environmental impacts, as well as the methods used for pollution control and sustainable practices.

79EV253.4: Introduced to modern environmental technologies and practices used in the field, enhancing their knowledge of current industry standards and innovations.

79EV253.5: Opportunity to interact with industry professionals, fostering connections that could lead to future internships, research collaborations, or job opportunities.

Scheme of Studies:

Course Category	CourseCode	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
P_fCC	79EV253	Industrial visit/Field work/ Educational tour	0	0	0	0	4	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Industrial Visit

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)			
			End Semester Assessment (ESA)			
			Field-work Report	Presentation	Viva - Voce	Total Marks
P_fCC	79EV253	Industrial visit/Field work/ Educational tour	40	20	40	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Guidelines for Project work

To provide hands on training expertise in research, field-work/industrial visit will be allotted to students of 2nd semester. The field site/ Industry can be selected and carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their report in the department as per the date announced for the submission.
Assessment of the Report will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates.

- The paper size to be used should be A-4 size.
- The font size should be12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and half) space

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of Life Science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

****

A K S University

Faculty of Life Science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV253
Course Title: Seminar/Workshop

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Apply theoretical concepts learned in the classroom to real-world environmental issues and scenarios.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Develop improved analytical and observational skills by examining environmental processes and conducting on-site data collection and analysis.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

CO3: Gain insights into various industrial processes and their environmental impacts, as well as the methods used for pollution control and sustainable practices.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Introduced to modern environmental technologies and practices used in the field, enhancing their knowledge of current industry standards and innovations.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO5: opportunity to interact with industry professionals, fostering connections that could lead to future internships, research collaborations, or job opportunities.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Semester-III

Course Code: 79EV301

Course Title: Environmental Microbiology & Biotechnology

Pre-requisite: Student should have basic knowledge of Microbiology & Biotechnology.

Rationale: Microbes are responsible for both production and destruction of foodstuffs and are a key element in reducing waste from spoilage.

Course Outcomes:

79EV301.1: Know about structure and classification of different microorganisms.
79EV301.2: Learn the importance of microorganisms in nutrient cycling.
79EV301.3: Executing methods of culture preparation.
79EV301.4: Apply biotechnological approaches in abatement of pollution.
79EV301. 5: Implementing biotechnology in waste water treatment.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV301	Environmental Microbiology & Biotechnology	3+1	0	1	1	5	4

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture(L) and Tutorial (T)and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment number 5 3 markseach (CA)	Class Test2 (2 best out of 3) 10 markseach (CT)	Seminar one	Class Activityy any one	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV 301	Environmental Microbiology & Biotechnology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

79EV301.1: Know about structure and classification of different microorganisms.

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	3
SL	2
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Understand theimportance of environmental microbiology **SO1.2**Learn Scope ofEnvironmental microbiology **SO1.3**Describe the Goal of structure of microorganisms **SO1.4**Know about microbial diversity **SO1.**5 know about theenvironmental aspectsof infectious diseases (water borne diseases). .		**Unit-1: Introduction to Environmental Microbiology** **1.1** Introduction, scope, **1.2** importance of environmental microbiology, **1.3** structure of microorganisms **1.4** Fungi, bacteria, virus, **1.5** classification of microorganisms. **1.6** Microbial diversity-1 **1.7** Microbial diversity-2 **1.8** Role of microorganisms in air, water **1.9** soil for microbial qualities. **1.10** Environmental aspects of infectious diseases (Water BornDiseases)-1	1. importance of environmental microbiology 2. classification of microorganisms.

		1.11 Environmental aspects of infectious diseases (Water Born Diseases)-2 **1.12 Tutorial-1** **1.13 Tutorial-2** **1.14 Tutorial-3** **1.15 Tutorial-4**	

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Describe the Structure and classification of different microorganisms

b. Mini Project:
Draw the Structure of bacteria.

c. Other Activities (Specify):
Role of microorganisms in air, water and soil for microbial qualities.

79EV 301.2: Learn the importance of microorganisms in nutrient cycling.

Approximate Hours

Item	Approx. Hrs.
Cl	09
LI	00
SW	04
SL	02
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**

SO2.1 Understand the fundamentals of microbiology. **SO2.2** Understand diversity of micro-organisms, bacteria cell structure and functions, microbial growth and metabolism. **SO2.3**To know the role of micro-organisms in food production and preservation. **SO2.4**Understand the role of microbes in nutrient cycling. **SO2.**5 Understand the role of microbes in environment.		**Unit-2: Microbial Diversity** 2.1 Fundamental concept of bacteria. 2.2 Actinomycetes. 2.3 Fundamental concept of Fungi. 2.4 Fundamental concept of actinomycetes. 2.5 Importance of microbes in nutrient cycling -1. 2.6 Importance of microbes in nutrient cycling -2. 2.7 Tutorial-1 2.8 Tutorial-2 2.9 Tutorial-3	i. Microbial diversity ii. Structure of different micro-organisms.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Fundamental concept of bacteria, fungi and actinomycetes.
ii. Importance of microbes in nutrient cycling.

b. Mini Project:
Structure of micro-organisms.

c. Other Activities
(Specify):Types of micro-organisms

79EV301.3: Executing methods of culture preparation.

Approximate Hours

Item	ApproX.Hrs.
Cl	12
LI	00
SW	3
SL	2
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO3.1know the Concept of Microbial Methods **SO3.2**Understand the Systematically apply the scientific method of investigation and hypothesis testing. **SO3.3** Students able to know the development of theoretical and practical skills in the design and execution of experiments. **SO3.4**understand the types of culture. **SO3.5** Know about the techniques used for enrichment of culture		**Unit-3: Microbial Methods** 3.1 Types of culture 3.2 Sterilization 3.3 Disinfection 3.4 Techniques used for enrichment of culture. 3.5 method of Pure culture. 3.6 Preparation 3.7 Maintenance of microbial culture 3.8 Pour plate, streak plate and Spread plate. 3.9 Preservation of microbial culture 3.10 Tutorial 1 3.11 Tutorial 2 3.12 Tutorial 3	i. sterilization ii. method of pure culture

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Write a report on Culture preparation

b. Mini Project:
Explain disinfection

c. Other Activities (Specify):
Maintenance of microbial culture

79EV301.4: Apply biotechnological approaches in abatement of pollution.

Approximate Hours

Item	Approx. Hrs.
Cl	12
LI	00
SW	03
SL	02
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Understanding basics of environmental biotechnology **SO4.2**learn about bioremediation **SO4.3**know about energy management **SO4.4**prepare about reclamation and restoration **SO4.**5 understand energy abatement		**Unit-4: Environmental Biotechnology** 4.1 Introduction to environmental biotechnology. 4.2 basic of environmental biotechnology. 4.3 Definition and Scope of biotechnology. 4.4Biotechnological approach of environmental pollution control. 4.5 Energy management-1. 4.6 Energy management-2. 4.7 Energy abatement-1. 4.8 Energy abatement-2. 4.9 Bioremediation-1 4.10 Bioremediation-2	i. Definition of environmental biotechnology ii. scope of environmental biotechnology

		4.11 Reclamation and restoration-1 4.12 Reclamation and restoration-2	

SW-4 Suggested Sessional Work (SW):

a. Assignments:
Introduction and basics of environmental biotechnology

b. Mini Project:
Describe briefly about bio remediation.

c. Other Activities (Specify):
Power point presentation on biotechnological approach of environmental pollution control

79EV301. 5: Implementing biotechnology in waste water treatment.

Item	Approx. Hrs.
Cl	12
LI	0
SW	3
SL	2
Total	17

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO5.1 understand mushroom cultivation **SO5.2**Know about vermiculture **SO5.3**Learn about bioethics **SO5.4** know about the microbes used in pollution mitigation **SO5.**5 Learn about bio-insecticide		**Unit 5: Biotechnology for Environmental Protection** 5.1 Scope of biotechnology in pollution control of population. 5.2 Bioremediation. 5.3 Microbes used in pollution mitigation-1. 5.4 Microbes used in pollution mitigation-2. 5.5 Bioleaching. 5.6 Biomining. 5.7 Wastewater treatment. 5.8 Bio-control agents-bio-pesticides. 5.9 bio-insecticide. 5.10 Mushroom cultivation and vermiculture-1. 5.11 Mushroom cultivation and vermiculture-2. 5.12 Bioethics and biosafety	1. Scope of biotechnology in pollution control of population 2. what is biomining

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Describe Bio-control agents-bio-pesticides

b. Mini Project:
Explain bioleaching

c. Other Activities(Specify):
What is biosafety?

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV301.1: Know about structure and classification of different microorganisms.	15	0	3	2	20
79EV301.2: Learn the importance of microorganisms in nutrient cycling.	9	0	4	2	15
79EV301.3: Executing methods of culture preparation.	12	0	3	2	17
79EV301.4: Apply biotechnological approaches in abatement of pollution.	12	0	3	2	17
79EV301. 5: Implementing biotechnology in waste water treatment.	12	0	3	2	17
Total Hours	60	00	16	10	86

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Introduction to Environmental Microbiology**	03	01	01	05
CO-2	**Microbial Diversity**	02	06	02	10
CO-3	**Microbial Methods**	03	07	05	15
CO-4	**Environmental Biotechnology**	-	10	05	15
CO-5	**Biotechnology for Environmental Protection**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply
The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration

8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT Blog ,Facebook ,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Microbiology	P.D. Sharma	Rastogi publication Meerut	
2	Environmental Biotechnology-Theory and Application	Evans, G.M. and Furlong J.C.John Wiley and Sons		2003
3	Biotechnology for Waste and Wastewater Treatment	Cheremisin off, N.P.	William Andrew Publishing, NewYork	1996
4	Biotechnological methods of Pollution control	Abbasi,S.A.andE.R a masami,UniversityP ress,Hyderabad		1999
5.	Basic Environmental Microbiology	Srivastava, M.L.,Manohar Books, NewDelhi		2003

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV301
Course Title: Environmental Microbiology & Biotechnology

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO 5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution	Moder n toolusage	Leadership skills	Profe ssional Identity	Environ mental Ethi cs	Communication	The Environmentand society	Environment and sustainability	Life- long learning	Proficiencyin Environmental Analysis and Assessment	Applicationof Multidisciplinary Approaches	Critical Thinkingand Problem-Solving Skills	Professional Ethicsand Social Responsibility
CO 1: Know about structure and classification of different microorganisms.	2	2	2	2	1	2	3	3	1	2	1	2	1	3	2	2

CO 2: Learn the importance of microorganisms in nutrient cycling.	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO 3: Executing methods of culture preparation.	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Apply biotechnological approaches in abatement of pollution.	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**3**	**2**	**3**
CO 5: Implementing biotechnology in waste water treatment.	**1**	**2**	**2**	**1**	**1**	**3**	**1**	**3**	**1**	**2**	**1**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Know about structure and classification of different microorganisms.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1.1,1.2,1. 3,1.4,1.5, 1.6	Unit-1 Introduction to Environmental Microbiology 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1 .10,1.11,1.12,1.13,1.14,1.15	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Learn the importance of microorganisms in nutrient cycling.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	2.1,2.2,2. 3,2.4,2.5	Unit-2 Microbial Diversity 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Executing methods of culture preparation.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3. 3,3.4,3.5, 3.6,3.7,3. 8,3.9,.3.1 0	Unit-3: Microbial Methods 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3 .11, 3.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Apply biotechnological approaches in abatement of pollution.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Environmental Biotechnology 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11,4.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Implementing biotechnology in waste water treatment.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit-5: Biotechnology for Environmental Protection 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.1 0,5.11,5.12	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Course code: 79EV302

Course Title: Research Methods and Paper Writing

Pre-requisite: Student should have basic knowledge of research methods and paper writing.

Rationale: research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing, and evaluating data; making deductions and reaching conclusions.

79EV302.1: Explain concept and methods of research.

79EV302.2: Apply statistical analysis in research

79EV302.3: Select statistical methods for research.

79EV302.4: Use MS office in data presentation.

79EV302.5: Know techniques of scientific paper writing.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+ SL)	
Program Core (PCC)	79EV302	Research Methods and Paper Writing	3+1	0	1	1	5	4

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T)and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA +CT+SA+CAT +AT)		
PCC	79EV 302	Research Methods and Paper Writing	15	20	5	5	5	50	50	100

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Theory
Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV302.1: Explain concept and methods of research.

Approximate Hours

Item	Approx. Hrs
Cl	12
LI	00
SW	03
SL	02
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.2Knowabout planning research projects SO1.3 Learn the way to prepare a research report SO1.4Know the classification of research		Unit-1: Fundamental 1.1 Concept & methods of research-1. 1.2 Concept & methods of research-2. 1.3 Classification research-1. 1.4 Classification of research-2. 1.5 Planning research projects-1. 1.6 Planning research projects-2. 1.7 measurement of research problems-1 1.8 measurement of research problems-2. 1.9 Use of sampling, &	1. What is research? 2. What are research problems?

		questionnaires construction for research-1. 1.10 use of sampling, & questionnaires construction for research-2. 1.11 processing of research data & preparation of research report- 1. 1.12 processing of research data & preparation	

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Write about use of sampling, & questionnaires construction for research

b. Mini Project:
Write in brief about the concept of research

c. Other Activities (Specify):
Presentation on methods of research and classification of research along with examples in both the topics

79EV302.2: Apply statistical analysis in research.

Approximate Hours

Item	Approx. Hrs
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO2.1learn about the concept of sampling and data collection **SO2.2**understand the measures of dispersion **SO2.3**student will be able to learn about probability SO2.4 know about standard deviation SO2.5 understand the tests of		Unit-2: **Statistical Analysis** 2.1 Sampling, data collection and recording, central tendency – concept-1 2.2 Sampling, data collection and recording, central tendency – concept-2	1. About statistics 2. About data collection

hypothesis and significance		2.3 arithmetic mean, mode, median for ungrouped and grouped data-1 2.4 arithmetic mean, mode, median for ungrouped and grouped data-2 2.5 measures of dispersion: absolute and relative measures-1 2.6 measures of dispersion: absolute and relative measures-2 2.7 standard deviation (grouped and ungrouped data) 2.8 variance 2.9 quartile deviation 2.10 coefficient of variability 2.11 probability-normal, poisson and binomial 2.12 tests of hypothesis and significance. 2.13 Tutorial-1 2.14 Tutorial-2 2.15 Tutorial-3	

SW-2 Suggested Sessional Work (SW):

a. Assignments:
Write about coefficient of variability with example

b. Mini Project
Write about arithmetic mean, mode, median for ungrouped and grouped data with examples

c. Other Activities (Specify):
About quartile deviation

79EV303A2.3: Select statistical methods for research.

Approximate Hours

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Item	Approx. Hrs
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Know the concept Pearson. **SO3.2**Learn about other correlation coefficients. **SO3.3** Understand the concept of hypothesis testing. SO3.4 know about the concept of correlation		**Unit- 3: Statistical Methods** 3.1 Hypothesis testing, significance and correlation-1 3.2 Hypothesis testing, significance and correlation-2 3.3 linear models and regressions-1 3.4 linear models and regressions-2 3.5 Pearson and other correlation coefficients-1 3.6 Pearson and other correlation coefficients-2 3.7 multiple Regressions 3.8 distribution- normal 3.9 T and CHI square test-1	a. What is correlation? b. What are linear models? .

		3.10 T and CHI square test-2 3.11 difference among means 3.12 F-test 3.13 Tutorial-1 3.14 Tutorial-2 3.15 Tutorial-3	

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Write about F-test

b. Mini Project:
Write about t and chi square test

c. Other Activities (Specify):
About difference among means

79EV302.4: Use MS office in data presentation.

Approximate Hours

Item	Approx. Hrs
Cl	06
LI	00
SW	03
SL	02
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO4.1 Learn about the fundamentals of computer **SO4.2**know about Microsoft Office **SO4.3**Understand about data presentation		**Unit-4: Computer** **4.1** Fundamental of computer 4.2 MS Office- word, excel, power point, statistical software for data analysis (SPSS)-1 4.3 MS Office- word, excel, power point, statistical software for data analysis (SPSS)-2 4.4 MS Office- word, excel, power point, statistical software for data analysis (SPSS)-3 4.5 Data presentation-1 4.6 Data presentation-2	1. Basics about computer 2. Basics about software

SW-4 Suggested Sessional Work (SW):

a. Assignments:
Write about the fundamentals of computer

b. Mini Project:
Write in brief about the features present in MS Office Word and Excel

c. Other Activities (Specify):
About different ways of data presentation

79EV302.5: Know techniques of scientific paper writing.

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Approximate Hours

Item	Approx. Hrs
Cl	12
LI	00
SW	03
SL	02
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO5.1know about the basic principles of research, design execution and reporting **SO5.2**understand the concept of research articles and research papers **SO5.3**Understand the concept of reviews and scientific paper articles **SO5.4** Know about the components of a research article		**Unit-5: Scientific Paper Writing** 5.1 Basic principles of research, design execution and reporting 5.2 concept of research articles, research papers, reviews, scientific popular articles-1 5.3 concept of research articles, research papers, reviews, scientific popular articles-2 5.4 concept of research articles, research papers, reviews, scientific popular articles-3 5.5 components of a research article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, copyright Act (in brief), plagiarism, Cheating / academic frauds-1	1. About the basic principles of research 2. About reporting

		5.6 components of a research article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, copyright Act (in brief), plagiarism, Cheating / academic frauds-2 5.7 components of a research article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, copyright Act (in brief), plagiarism, Cheating / academic frauds-3 5.8 components of a research article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, copyright Act (in brief), plagiarism, Cheating / academic frauds-4 5.9 process of reviewing 5.10 Concept of Impact factor 5.11 H-Index 5.12 Tutorial-1	

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

Write about the process of reviewing and the concept of impact factor

b. Mini Project:
Write about H-index

c. Other Activities (Specify):
Presentation on the components of a research article

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV302.1: Explain concept and methods of research	12	0	3	2	17
79EV302.2: Apply statistical analysis in research.	15	0	3	2	20
79EV302.3: Select statistical methods for research.	15	0	3	2	20
79EV302.4: Use MS office in data presentation.	6	0	3	2	11
79EV302.5: Know techniques of scientific paper writing.	12	0	3	2	17
Total Hours	60	0	15	10	85

Brief of Hours suggested for the Course Outcome

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Statistical Analysis**	02	06	02	10
CO-3	**Statistical Methods**	03	07	05	15
CO-4	**Computer**	-	10	05	15
CO-5	**Scientific Paper Writing**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply
The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial

3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mail Online resources)
9. Brainstorming

Suggested Learning Resources:

(f) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	An introduction to Statistical Methods	23rd revised edition :C.B.Gupta&Vijay G upta	Vikas Publishing House Pvt Ltd, Noida	2015
2	Statistical Methods	S.C.Gupta		

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV302

Course Title: Research Methods and Paper Writing

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Envir onme ntal Kno wledg e	Pla nni ng abil itie s	Pro ble m anal ysis	Desi gn/d evel opm ent of solut ion for prob lems	Mod ern tool usag e	Lea der shi p skil ls	Profe ssion al Ident ity	Envi ron men tal Ethi cs	Com mun icati on	The Envi ron men t and socie ty	Envir onme nt and sustai nabili ty	Life- long learni ng	Proficienc y in Environm ental Analysis and Assessmen t	Application of Multidiscip linary Approache s	Critical Thinking and Problem- Solving Skills.	Professional Ethics and Social Responsibili ty
CO1 : Explain concept and methods of research.	2	1	2	2	3	2	3	1	2	1	2	2	2	3	2	1
CO 2 : Apply statistical analysis in research.		1	2	2	1	2	3	2	1	1	2	2	2	2	2	1

CO3 : Select statistical methods for research.	**2**	**2**	**3**	**1**	**1**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**3**	**2**
CO 4: Use MS office in data presentation.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**1**	**1**	**2**	**3**	**3**	**3**	**2**	**2**
CO 5: Know techniques of scientific paper writing.	**2**	**2**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**2**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Explain concept and methods of research	SO1.1SO1.2SO1.3SO 1.4 SO1.5	1.1,1.2	Unit-1: **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11, 1.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2:Apply statistical analysis in research	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3	Unit-2: **Statistical Analysis** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11 ,2.12 ,2.13,2.14,2.15	
PO1,2,3,4,5,6 7,8,9,10,11,12	CO3: Select statistical methods for research	SO3.1SO3.2 SO3.3	3.1	Unit-3: Statistical Methods	
PSO 1,2, 3, 4		SO3.4 SO3.5		3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11, 3.12,3.13,3.14,3.15	
PO1,2,3,4,5,6	CO 4: Use MS office in data	SO4.1SO4.2SO4.3SO	4.1,4.2	Unit-4: Computer	
7,8,9,10,11,12	presentation	4.4			

		SO4.5			
PSO 1,2, 3, 4				4.1, 4.2,4.3,4.4,4.5,4.6	
PO1,2,3,4,5,6	CO 5: Know techniques of scientific paper writing.	SO5.1SO5.2SO5.3SO	5.1	Unit 5: Scientific Paper Writing	
7,8,9,10,11,12		5.4			
		SO5.5		5.1,5.2,5.3,5.4,5.5,5.6 ,5.7, 5.8, 5.9,	
PSO 1,2, 3, 4				5.11,5.12	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Course Code:	79EV303A
Course Title:	National issues & disaster management
Pre-requisite:	Student should have basic knowledge about pollution and its sources.
Rationale:	The students studying Environmental Science should possess foundational understanding about pollution and their effects. Students need to be able to identify the types of pollution, the sources of pollution and how they can protect the environment from further pollutants.

Course Outcomes:

79EV303A.1: Explain natural and manmade disaster and associated socio-economic impact.
79EV303A.2: Discuss key concepts, definitions and perspectives of disaster Management.
79EV303A.3: Describe the Disaster Management Cycle.
79EV303A.4: Implement planning for hazard mitigation.
79EV303A.5: Know about social issues like child labour, child marriage etc.

Scheme of Studies:

			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW +SL)	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Program Core (PCC)	79EV303A	National issues & disaster management	3+1	0	1	1	5	4

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture(L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)		
			Progressive Assessment (PRA)	End Semester Assessment	Total Marks

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	79EV 303A	National issues & disaster management	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV303A.1: Explain natural and manmade disaster and associated socio-economic impact.

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

SO1.1 Learn solid waste problem **SO1.2** Know about low carbon lifestyles **SO1.3** Observe the effects of GHGs emission **SO1.4** Understand about environment **SO1.5** Learn about factors responsible for environmental issues		**Unit-1 Environmental Issues** **1.1** Delhi case study-1 **1.2** Delhi case study-2 **1.3** Delhi case study-3 **1.4** solid waste problem-1 **1.5** solid waste problem-2 **1.6** population growth & environment-1 **1.7** Population growth & environment-2 **1.8** population growth & environment-3 **1.9** water crisis in India-1 **1.10** water crisis in India-2 **1.11** GHG_s emission & low carbon lifestyles–1 **1.12** GHG_s emission & low carbon lifestyles-2 **1.13** Tutorial-1 **1.14** Tutorial-2 **1.15** Tutorial-3	**1.** Solid waste **2.** GHGs emission

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Report on Delhi case.

b. Mini Project:
Effects of population growth on environment.

c. Other Activities (Specify):
Presentation on reasons for water crisis in India

79EV303A.2: Discuss key concepts, definitions and perspectives of disaster Management.

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (Cl)**	**Self-Learning (SL)**
SO2.1 Learn reasons of poverty **SO2.2** Know effects of poor education in Nation's development **SO2.3**Analyze sanitation issues **SO2.4 Learn** about sanitation diseases		Unit-2 **Social Issues** 2.1 Illiteracy 2.2 poverty 2.3child marriage 2.4 child labour 2.5 Sanitation issues & diseases-1 2.6 Sanitation issues &	i. illiteracy ii. Child marriage

SO2.5Understand reasons for food wastage		diseases-2 2.7 Poor education 2.8 Poor education 2.9 less opportunity for youth 2.10 food wastage 2.11 Health issues-1 2.12 Health issues-2 2.13 Tutorial-1 2.14 Tutorial-2 2.15 Tutorial-3	

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Reasons for health issues
b. Mini Project:
Reasons of increased health issues
c. Other Activities (Specify):
Penal provisions regarding child marriage and child labour.

79EV303A.3: Describe the Disaster Management Cycle.

Approximate Hours

Item	Approx. Hrs.
Cl	14
LI	00
SW	03
SL	01
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (Cl)	Self-Learning (SL)

SO3.1 Know the types of disaster **SO3.2** Learn causes of natural disasters **SO3.3** Describe NDMA **SO3.4** Analyze effects of natural disasters **SO3**.5 Understand BLEVE.		**Unit-3: Fundamental of Disaster** 3.1 Disasters- definition & types 3.2 chemical disaster-1 3.3 chemical disaster-2 3.4 BLEVE 3.5 natural disasters & artificial disaster-causes & effects-1 3.6 natural disasters & artificial disaster-causes & effects-2 3.7 case studies in India 3.8 Disaster management authorities in India- NDMA & NIDM-1 3.9 Disaster management authorities in India- NDMA & NIDM-2 3.10 Disaster management authorities in India- NDMA & NIDM-3 3.11 Hazchem code- a basic concept 3.12 Tutuorial-1 3.13 Tutuorial-2 3.14 Tutuorial-3	What is the meaning of disaster?

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
Case studies related to disaster in India

b. Mini Project:
Definition and types of disaster

c. **Other Activities (Specify):**
About Hazchem code

79EV303A.4: Implement planning for hazard mitigation.

Approximate Hours

Item	Approx. Hrs.

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Cl	10
LI	00
SW	03
SL	02
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (Cl)	Self-Learning (SL)
SO4.1 Learn about definition of risk **SO4.2**know about risk assessment **SO4.3**Understand about risk management **SO4.4**Describe dose-response assessment **SO4.**5 understand environmental risk		**Unit-4: Risk Assessment** 4.1 Risk analysis-definition of risk 4.2 Environmental risk analysis 4.3 Environmental risk analysis 4.4 Risk assessment and risk management 4.5 Risk assessment and risk management 4.6 Basic steps in risk assessment - hazard identification, dose-response assessment exposure assessment, Risk characterization-1 4.7 Basic steps in risk assessment - hazard identification, dose-response assessment exposure assessment, Risk characterization-2 4.7 Basic steps in risk assessment - hazard identification, dose-	i. Environmental risk ii. Risk management

		response assessment exposure assessment, Risk characterization-3 4.8 Tutorial-1 4.9 Tutorial-2 4.10 Tutorial-3	

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Basic steps in risk management

b. Mini Project
Definition of risk

c. **Other Activities (Specify):**
Examples of risk assessment and risk management

79EV303A.5: Know about social issues like child labour, child marriage etc.

Approximate Hours

Item	Approx. Hrs.
Cl	06
LI	00
SW	03

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

SL	02
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO5.1 know about disaster management **SO5.2** Understand pre disaster management **SO5.3** Describe post disaster management		**Unit-5: Disaster management** 5.1 Pre & post disaster management, planning, prevention, mitigation, preparedness, response-1 5.2 Pre & post disaster management, planning, prevention, mitigation, preparedness, response-2 5.3 Pre & post disaster management, planning, prevention, mitigation, preparedness, response-3 5.4 Guide lines for disaster management 5.5 Tutorial-1 5.6 Tutorial-2	i. What is disaster management ii. Pre disaster management

SW- 5 Suggested Sessional Work (SW):

a. **Assignments:**
Different steps involved in pre and post disaster management
b. Mini Project:
Guidelines for disaster management
c. **Other Activities (Specify):**
Examples of pre and post disaster management

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instructions (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV303A.1: Explain natural and manmade disaster and associated socio-economic impact.	15	0	3	2	20
79EV303A.2: Discuss key concepts, definitions and perspectives of disaster Management.	15	0	3	2	20
79EV303A.3: Describe the Disaster Management Cycle.	14	0	3	1	18
79EV303A.4: Implement planning for hazard mitigation.	10	0	3	2	15
79EV303A.5: Know about social issues like child labour, child marriage etc.	**6**	**0**	**3**	**2**	**11**
Total Hours	**60**	**00**	**15**	**9**	**84**

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Environmental Issues**	03	01	01	05
CO-2	**Social Issues**	02	06	02	10
CO-3	**Fundamental of Disaster**	03	07	05	15
CO-4	**Risk Assessment**	-	10	05	15
CO-5	**Disaster management**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply
The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(c) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Population, Environment and Society	Borrie	W.D., O.U.P., U.K.	1988
2	Geology, Environment and Society	Valdiya	K.S., Universities Press.	2004
3	Technology and Global Environmental issues	Makofske, W.J. and Karlin, E.F., Addison Wesley, Toronto		1995
4	Geological Hazards- Their Assessment ,Avoidance and Mitigation	Bell.F.G, E & F N Spon	e- Books der ULB Darmstadt.	1999

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV303A

Course Title : National issues & disaster management

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Kno wledge	Planning abilitie s	Pro ble m analysis	Design/devel opment of solut ion for problems	Modern tool usage	Leadershi p skills	Professional Identity	Environ mental Ethics	Communication	The Environ ment and society	Environment and sustainabili ty	Life- long learning	Proficiency in Environmental Analysis and Assessment	Applicationof Multidiscip linary Approache s	Critical Thinkingand Problem-Solving Skills	Professional Ethics and Social Responsibility

CO1: Explain natural and manmade disaster and associated socio-economic impact.	**1**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO 2: Discuss key concepts,definitions and perspectives of disaster Management..	**1**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Describe the Disaster Management Cycle.	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Implement planning for hazard mitigation.	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Know about social issues like child labour, child marriage etc.	**2**	**1**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1: Explain natural and manmade disaster and associated socio-economic impact.	SO1.1SO1.2SO1.3SO1.4 SO1.5	1.1,1.2,1.3,1.4,1.5,1.6	Unit-**1 Environmental Issues** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12,1.13,1.14,1.15	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Discuss key concepts, definitions and perspectives of disaster Management.	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3	Unit-2 **Social Issues** 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10,2.11,2.12,2.13,2.14,2.15,	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Describe the Disaster Management Cycle.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5	3.1,3.2,3.3,3.4	Unit-3: **Fundamental of Disaster** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7, 3.8,3.9,3.10,3.11,3.12,3.13,3.14	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Implement planning for hazard mitigation.	SO4.1SO4.2SO4.3SO4.4 SO4.5	4.1,4.2,4.3	Unit-4: **Risk Assessment** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7 ,4.8,4.9,4.10	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Know about social issues like child labour, child marriage etc.	SO5.1SO5.2SO5.3SO5.4 SO5.5	5.1,5.2	Unit 5: **Disaster management** 5.1,5.2,5.3,5.4,5.5,5.6	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Course code: 79EV303B

Course Title: Environmental Toxicology

Pre-requisite: Student should have basic knowledge about environmental toxicology.

Rationale: To study about the adverse and harmful environmental chemicals on human health.

Course Outcomes:

79EV303B.1: Discuss concept of toxins, toxicity and toxicology.
79EV303B.2: Know toxicity assessment.
79EV303B.3: Identify vector borne disease.
79EV303B.4: Learn about industrial toxicology.
79EV303B.5: Describe occupational health.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV303 B	Environmental Toxicology	3+1	0	1	1	5	4

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (C A +CT+SA+CAT+ AT)	(ESA)	(PRA + ESA)
PCC	79EV 303B	Environmental Toxicology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom

Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV303B.1: Discuss concept of toxins, toxicity and toxicology.

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Understand the concept of toxins. **SO1.2**Know the levels of toxicity. **SO1.3** Learn the chemical factors affecting toxicity **SO1.4**Know the relationship between dose effect and dose response **SO1.**5 Learn about toxic compounds		**Unit-1: Fundamental** 1.1 Concept of toxins 1.2 toxicity and toxicology-1 1.3 toxicity and toxicology-2 1.4 Classification of toxic compounds-1 1.5 Classification of toxic compounds-2 1.6 Dose effect and Dose response relationship 1.7 levels of toxicity – acute, sub-acute and chronic-2	1. What is toxicity? 2. What is toxicology ?

		1.8 levels of toxicity – acute, sub-acute and chronic-2 1.9 classification of toxicants–factors that affect environmental concentration of toxicants-1 1.10 classification of toxicants–factors that affect environmental concentration of toxicants-2 1.11 Chemical and biological Factors influencing toxicity-1 1.12 Chemical and biological Factors influencing toxicity-2 1.13 Tutorial-1 1.14 Tutorial-2 1.15 Tutorial-3	

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Factors that affect environmental concentration of toxicants.

b. Mini Project:
Concept of toxicity and toxicology

c. Other Activities (Specify):
Presentation on classification of toxic compounds

79EV303B.2: Know toxicity assessment.

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Learn the concept of LD50. **SO2.2** Know about biotransformation **SO2.3** Understand the concept of ED50		Unit-2 **Toxicity Assessment** 2.1 Concept of LC50, LD50 and ED50-1 2.2 Concept of LC50, LD50 and ED50-2 2.3 Concept of LC50, LD50 and ED50 - 3 2.4 Biotransformation, biomagnification, bioconcentration, bioaccumulation, bio activation toxicants in ecosystem-1 2.5 Biotransformation, biomagnification, bioconcentration, bioaccumulation, bio activation toxicants in ecosystem-2 2.6 Biotransformation, biomagnification, bioconcentration, bioaccumulation, bio activation toxicants in ecosystem-3 2.7 Biotransformation, biomagnification, bioconcentration, bioaccumulation, bio activation toxicants in ecosystem-4 2.8 Biotransformation, biomagnification, bioconcentration, bioaccumulation, bio activation toxicants in ecosystem-5 2.9 Bioassay methods using plants and animal model-1 2.10 Bioassay methods using plants and animal model- 2 2.11 Bioassay methods using plants and animal model-3	iii. Concept of LC50 iv. Concept of bioaccumulation

		2.12 Tutorial-1 2.13 Tutorial-2 2.14 Tutorial-3 2.15 Tutorial-4	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

Biotransformation, biomagnification, bioconcentration, bioaccumulation, bioactivation toxicants in ecosystem

b. Mini Project:

Write a report on Bioassay methods using plants and animal model

c. Other Activities (Specify):

Concept of LC50 and ED50

79EV303B.3: Identify vector borne disease.

Approximate Hours

Item	Approx. Hrs.
Cl	12
LI	00
SW	03
SL	02
Total	17

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO3.1 Know the concept of epidemiological study **SO3.2**Learn the monitoring techniques with respect to arsenicosis **SO3.3**Understand the concept of vector borne disease.		**Unit-3: Epidemiological study** 3.1 Concept 3.2 monitoring techniques with respect to Arsenicosis and Flouorosis-1 3.3 monitoring techniques with respect to Arsenicosis and Flouorosis-2 3.4 monitoring techniques with respect to Arsenicosis and Flouorosis-3 3.5 monitoring techniques with respect to Arsenicosis and Flouorosis-4 3.6 vector borne disease Environmental risk evaluation and management: an overview-1 3.7 vector borne disease Environmental risk evaluation and management: an overview-2 3.8 vector borne disease Environmental risk evaluation and management: an overview-3 3.9 Tutorial-1 3.10 Tutorial-2 3.11 Tutorial-3 3.12 Tutorial-4	i. What is arsenicosis? ii. What is flouorosis?

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Environmental risk evaluation

b. Mini Project:
monitoring techniques with respect to Fluorosis

c. Other Activities (Specify):
About environmental risk management

79EV303C.4: Learn about industrial toxicology.

Approximate Hours

Item	Approx. Hrs.
Cl	10
LI	00
SW	03
SL	02
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)

SO4.1 Learn about the basic concept of environmental health **SO4.2**know about the relevant stresses **SO4.3**Understand the relationship of industrial toxicology with occupation and hygiene		**Unit-4: Environmental health** 4.1 Basic concept Physiological responses of man to relevant stresses in the environment-1 4.2 Basic concept Physiological responses of man to relevant stresses in the environment-2 4.3 Industrial toxicology and its relationship with occupation and hygiene and also diseases-1 4.4 Industrial toxicology and its relationship with occupation and hygiene and also diseases-2 4.5 Industrial toxicology and its relationship with occupation and hygiene and also diseases-3 4.6 Industrial toxicology and its relationship with occupation and hygiene and also diseases-4 4.7 Tutorial-1 4.8 Tutorial-2 4.9 Tutorial-3	iii. Environmental health iv. Industrial toxicology

SW-4 Suggested Sessional Work (SW):

a. Assignments:
Physiological responses of man to relevant stresses in the environment

b. Mini Project:
Make a PPT on industrial toxicology

c. Other Activities (Specify):
About diseases in relation to industrial toxicology

79EV303B.5: Describe occupational health.

Approximate Hours

Item	Approx. Hrs.
Cl	08
LI	00
SW	03
SL	02
Total	13

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**

SO5.1know about the basic principles of occupational health. **SO5.2**understand diseases related to occupation **SO5.3**Describe the hygiene relationships with regards to the occupation		**Unit-5: Occupational health** 5.1 Basic principles of occupational health 5.2 the occupation- hygiene relationship, safety and diseases-1 5.3 the occupation- hygiene relationship, safety and diseases-2 5.4 Health maintenance: Survey, analysis and recommendations regarding health and safety problems in the working and livingenvironment-1 5.5 Health maintenance: Survey, analysis and recommendations regarding health and safety problems in the working and livingenvironment-2 5.6 Tutorial-1 5.7 Tutorial-2 5.8 Tutorial-3	i. What is occupational health? ii. Health and safety problems in the working and living environment

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

Recommendations regarding health and safety problems in the working and living environment.

b. Mini Project:
Report on safety and diseases regarding the occupation

c. Other Activities (Specify):
Presentation on basic principles of occupational health

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV303B.1: Discuss concept of toxins, toxicity and toxicology.	15	0	3	2	20
79EV303B.2: Know toxicity assessment.	15	0	3	2	20
79EV303B.3: Identify vector borne disease.	12	0	3	2	17
79EV303B.4: Learn about industrial toxicology.	10	0	3	2	15
79EV303B.5: Describe occupational health.	8	0	3	2	13
Total Hours	60	00	15	10	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05

CO-2	**Toxicity Assessment**	02	06	02	10
CO-3	**Epidemiological study**	03	07	05	15
CO-4	**Environmental health**	-	10	05	15
CO-5	**Occupational health**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply
The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(e) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Environmental biology and toxicology	P.D.Sharma		1997-98
2	Modern toxicology	P.K.gupta and D.K.Shinlee	Stanely Lewis Publishers	
3	Elements of Toxicology	ShuklaJ.P andPandey	Radhapubl.,New Delhi	
4	Fundamentals of Ecotoxicology	Newman,M.C,Lawrence,C.A.,and Unger.	M.A.,2002,2 ND Ed,CRC Press, Boca Raton, Florida	

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV303B
Course Title: Environmental Toxicology

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for problems	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and sustainability	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1. Discuss concept of toxins, toxicity and toxicology.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2: Know toxicity assessment	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Identify vector borne disease.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2

CO 4: Learn about industrial toxicology.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**
CO 5: Describe occupational health	**2**	**2**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1. Discuss concept of toxins, toxicity and toxicology.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1 **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12 ,1.13,1.14,1.15	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Know toxicity assessment	SO2.1SO2.2SO2.3 SO2.4 SO2.5	2.1,2.2,2.3,2.4,2.5,2.6, 2.7	Unit-2 **Toxicity Assessment** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.13,2.14,2.15	
PO1,2,3,4,5,6 7,8,9,10,11,12	CO3: Identify vector borne disease.	SO3.1SO3.2 SO3.3		Unit-3: **Epidemiological study**	
		SO3.4		3.1,	As mentioned in page
PSO 1,2, 3, 4		SO3.5		3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12	number

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Learn about industrial toxicology.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Environmental health** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Describe occupational health	SO5.1SO5.2SO5.3SO5.4 SO5.5	5.1,5.2,5.3,5.4	Unit 5: **Occupational health** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Course Code: **79EV304A**

Course Title: Environmental Laws, Policies and Ethics

Pre-requisite: Course Assessment methods (Continuous (CT) and end assessment (EA))

Rationale: Environmental law describes a network of regulations and customary laws that address the effects of human activity on the natural environment. These laws are also referred to as environmental and natural resource laws and center on the idea of environmental pollution.

Course Outcomes:

79EV304A.1: Explain fundamental concepts in environmental law and policy.

79EV304A.2: Describe the main Environmental Law and Policy regime of the country.

79EV304A.3: Outline various international environmental laws in incorporated into environmental policies of national and state governments.

79EV304A.4: Examine and analyse legal approaches to pollution control, environmental planning and natural resource management.

79EV304A.5: Relate implementation issues associated with environmental regulation and environmental regimes.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hour (CI+LI+SW +SL)	
Program Core (PCC)	79EV304A	Environmental Laws, policies & Ethics	3+1	0	1	1	5	4

Legend: I: Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacherto ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment(Marks)**							
			Progressive Assessment (PRA)						**End Semester Assessment**	**Total Marks**
			Class/ Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**ESA)**	(PRA + ESA)
PCC	79EV304A	Environmental laws, policies & Ethics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels,

which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV304A.1: Explain fundamental concepts in environmental law and policy.

Approximate Hours

Item	Approx. Hrs.
Cl	13
LI	00
SW	03
SL	02
Total	18

Session Outcomes (SO)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Learn the international efforts for environmental protection. **SO1.2**Know the scheme of environment friendly products. **SO1.3**Learn about biosafety-issues. **SO1.4**understand the basic concept of IPR. **SO1.5** describe protocol. .		**Unit-1 Introduction** 1.1 National efforts forenvironmental protection. 1.2 International efforts for environmental protection-1 1.3 International efforts for environmental protection-2 1.4 Scheme of environmentally friendly products 1.5 Scheme of environmentally friendly products-1	1. Nationalefforts for environmental protection. 2. Labeling of environmentally friendly products (eco mark).

		1.6 Scheme of environmentally friendly products-2 1.7 Labeling of environmentally friendly products (eco-mark). 1.8 Biosafety-issues 1.9 Protocol 1.10 IPR-basic concept 1.11 Tutorial-1 1.12 Tutorial-2 1.13 Tutorial-3	

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
Describe the labelling of environmentally friendly products (ecomark).

b. Mini Project:
Explain in brief the issues related to biosafety.

c. Other Activities (Specify):
Presentation on IPR.

79EV304A.2: Describe the main Environmental Law and Policy regime of the country.

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Session Outcomes (SO)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO2.1 Learn about forest conservation. **SO2.2** Know about hazardous waste. **SO2.3** Know the importance of environment protection **SO2.4**Understand air pollution control **SO2.**5 Learn about water (prevention and control of pollution) Act, 1974		Unit-2 **Environmental Laws** 2.1 Environment (Protection) Act 1986. 2.2 Forest Conservation Act 1980. 2.3 Wildlife (Protection)Act1972 2.4 Water (Prevention and Control of Pollution) Act 1974. 2.5 Air (Prevention and Control of Pollution) Act 1981 2.6 Bio-Medical Waste (Management & Handling)Rules ,1998-1. 2.7 Bio-Medical Waste (Management & Handling)Rules ,1998-2. 2.8 Hazardous Waste (Management, Handling Rules,1989)-1. 2.9 Hazardous Waste (Management, Handling Rules,1989)-1. 2.10 Plastics manufacture-1. 2.11 Plastics manufacture-2. 2.12 Sale and Usage Rules1999. 2.13 Public Liability InsuranceAct, 1991 2.14 Municipal Solid Waste (Management & Handling)Rule,2000. 2.15 Tutorial--1	i. Components of environment ii. Afforestation

SW-2 Suggested Sessional Work (SW):

a. Assignments:
Necessity of environment conservation

b. Mini Project:
Strategies for forest conservation

c. Other Activities (Specify):
Constitutional provisions regarding protection of environment

79EV304A.3: Outline various international environmental laws in incorporated intoenvironmental policies of national and state governments.

Approximate Hours

Item	Approx.Hrs.
Cl	10
LI	00
SW	03
SL	02
Total	15

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO3.1 Know the national policies related to environment. **SO3.2**understand safeguards for environmental protection. **SO3.3**Learn about regulatory framework. **SO3.4**understand environmental policies. **SO3.**5 describe about regulatory framework.		**Unit-3: Environmental Policy in India** 3.1 National Environmental Policy 3.2 National Policy 3.3 Regulatory Framework-1 3.4 Regulatory Framework-2 3.5 Rule & regulations of central State Government and Central & State pollution control boards-1 3.6 Rule & regulations of central State Government and Central & State pollution control boards-2 3.7 Safeguard for EnvironmentalProtection-1 3.8 Safeguard for EnvironmentalProtection-2 3.9 Environmental policies 3.10 Tutorial-1	i. National environmental policy ii. Regulatory framework

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Safeguards for environmental protection

b. Mini Project:
Authorities related to pollution control

c. Other Activities (Specify):
Collect the list of national environment policies

79EV304A.4: Examine and analyse legal approaches to pollution control, environmental planning and natural resource management.

Approximate Hours

Item	Approx. Hrs.
Cl	13
LI	00
SW	03
SL	02
Total	18

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO4.1 Learn about Stockholm Conference on Human Environment, 1972 **SO4.2**know about Ramsar convention on wetlands, 1971 **SO4.3**describe earth summit at Rio de janerio, 1992 **SO4.4** prepare about Copenhagen summit, 2009 **SO4.**5 understand evolution and development of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972		**Unit-4: Environmental Treaties and Conventions** 4.1 Evolution and development of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972 4.2 Ramsar Convention on Wetlands, 1971 4.3MontrealProtocol, 1987 4.4Basel Convention (1989, 1992) 4.5 Earth Summit at Rio de Janeiro, 1992 4.6 Kyoto Protocol,161997 4.7 Earth Summit at Johannesburg, 2002 4.8 UN Summit on Millennium Development Goals 2000 4.9 Copenhagen Summit 2009 4.10 Tutorial-1 4.11 Tutorial-2 4.12 Tutorial-3 4.13 Tutorial-4	i Evolution of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972 ii.Montreal protocol,1987

SW-4 Suggested Sessional Work (SW):

a. Assignments:

Write about Kyoto protocol

b. Mini Project:

Write a report on UN Summit on Millennium Development Goals 2000

c. Other Activities (Specify):

Power Point Presentation on Basel Convention (1989, 1992)

79EV304A.5: Relate implementation issues associated with environmental regulation and environmental regimes.

Approximate Hours

Item	Approx. Hrs.
Cl	09
LI	00
SW	03
SL	02
Total	14

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Learn about valueeducation **SO5.2** Describe the basic concepts of ethics. **SO5.3** Describe the role of NGOs		**Unit-5 Environmental Ethics** 5.1 Basic concepts of ethics 5.2 value education	i. What is the role of NGOs in environmental protection?

in environmental protection **SO5.4** Understand environmentally significant days **SO5.**5 Learn corporate social responsibility		5.3 corporate social responsibility 5.4 Movements related to Environment – Chipko movement, Narmada bachao aandolan, Silent Valley 5.5 Role of NGOs in environmental protection 5.6 Environmental Significant Days 5.7 Tutorial-1 5.8 Tutorial-2 5.9 Tutorial-3	ii. Narmada bachao aandolan

SW- 5 Suggested Sessional Work (SW):

a. Assignments:
Define basic concepts of ethics.

b. Mini Project:
Chipko movement

c. Other Activities (Specify):
About silent valley

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+LI+SW+Sl)
79EV304A.1: Explain fundamental concepts inenvironmental law and policy.	13	0	3	2	18
79EV304A.2: Describe the main Environmental Law and Policy regime of the country.	15	0	3	2	20
79EV304A.3: Outline various international environmental laws in incorporated into environmental policies of national and state governments.	10	0	3	2	15
79EV304A.4: Examine and analyse legal approaches to pollution control, environmental planning and natural resource management.	13	0	3	2	18
79EV304A.5: Relate implementation issues associated with environmental regulation and environmental regimes.	9	0	3	2	14
Total Hours	60	00	15	10	85

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Introduction**	03	01	01	05
CO-2	**Environmental Laws**	02	06	02	10
CO-3	**Environmental Policy in India**	03	07	05	15
CO-4	**Environmental Treaties andConventions**	-	10	05	15
CO-5	**Environmental Ethics**	03	02	-	05
Total		11	26	13	50

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

Legend : Remember, U:Understand, A:Apply

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(b) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Environmental Lawand Policy	Diwan Shyam and Rosencranz Armin		2002
2	Environment and Pollution Law	Mohanty	S.K.,Universal LawPublishing Co. Pvt.Ltd.	2004
3	Environmental law in India	Shastri	S.C. Eastern BookCo, Lucknow	2008
4	S.C. Eastern Book Co,Lucknow	An invitation to Environmental philosophy: Des Jardius, J.R.,(3rdEd.)	Wadsworth Publication, Belmont, California	2001

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV304A

Course Title: Environmental Laws, Policies and Ethics

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilitie s	Pro ble m analysis	Design/devel opment of solut ion for problems	Modern tool usage	Leadershi p skills	Professional Identity	Environ mental Ethics	Communication	The Environ ment and society	Environment and sustainabili ty	Life- long learning	Proficiency in Environmental Analysis and Assessment	Applicationof Multidiscip linary Approache s	Critical Thinkingand Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1. Explain fundamental concepts in environmental law and policy.	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1

CO 2: Describe the main Environmental Law and Policy regime of the country.	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Outline various international environmentallaws in incorporated into	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
environmental policies of national and state governments.																
CO 4: Examine and analyse legal approaches to pollution control, environmental planning and natural resource management	**3**	**2**	**1**	**2**	**3**	**1**	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**3**	**2**
CO 5: Relate implementation issues associated with environmental regulation and environmental regimes	**2**	**1**	**1**	**1**	**1**	**3**	**1**	**3**	**1**	**1**	**2**	**2**	**3**	**2**	**1**	**3**

AKS UNIVERSITY

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1. Explain fundamental concepts in environmental law and policy.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1.1,1.2,1.3,1.4,1.5,1.6, 1.7,1.8,1.9	Unit-1 **Introduction** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12,1.13	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Describe the main Environmental Law and Policy regime of the country.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	2.1,2.2,2.3,2.4	Unit-2 **Environmental Laws** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.13,2.14,2.15	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Outline various international environmental laws in incorporated into environmental policies of national and state governments.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	3.1, 3.2,3.3	Unit-3: **Environmental Policy in India** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Examine and analyse legal approaches to pollution control, environmental planning and naturalresource management	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: **Environmental Treaties and Conventions** 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12,4.13	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Relate implementation issues associated with environmental regulation and environmental regimes	SO5.1SO5.2SO5.3 SO5.4 SO5.5		Unit 5: **Environmental Ethics** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8,5.9	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Course Code:	79EV304B
Course Title:	Environmental Statistics and Modeling
Pre-requisite:	Student should have basic knowledge about environmental statistics and modeling.
Rationale:	To study about the adverse and harmful environmental chemicals on human health.

Course Outcomes:

79EV304B.1: Develop an intuitive statistical sense for inferring meaning out of data collected from different environmental matrices
79EV304B.2: Implement statistics for environmental monitoring and sampling
79EV304B.3: Analyse, model and quantify uncertainty and variability in environmental data.
79EV304B.4: Extract information and draw scientific inference from large amount of data collected to solve environmental problems
79EV304B.5: Apply statistical tools and software to analyze environmental data.

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	Scheme of studies (Hours/Week)					**Total Credits (C)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours (CI+LI+SW+SL)**	
Program Core (PCC)	79EV304B	Environmental Statistics and Modeling	3+1	0	1	1	5	4

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e., Lecture(L) and Tutorial (T)and

others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	79EV 304B	Environmental Statistics and Modeling	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV304B.1: Need for studying environmental statistics.

Approximate Hours

Item	Approx. Hrs.
Cl	13
LI	00
SW	03
SL	02
Total	18

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO1.1 Understand the concept population and samples **SO1.2** Know the tabulation of data **SO1.3** Students will be able to understand frequency tables and frequency curves **SO1.4** Understand the concept of mean median and mode **SO1.5** Understand about probability		**Unit-1: Fundamental statistics** 1.1 Population and samples 1.2 tabulation of data 1.3 frequency tables and frequency curves-1 1.4 frequency tables and frequency curves-2 1.5 mean, mode and median- 1 1.6 mean, mode and median- 2 1.7 variance and standard deviation-1 1.8 variance and standard deviation-2 1.9 coefficient to variation-1 1.10 coefficient to variation- 2 1.11 data presentation techniques	1. What is frequency tables and frequency curves 2. Data presentation techniques

		1.12 Probability 1.13 Tutorial-1	

SW-1 Suggested Sessional Work (SW):

a. Assignments:
Write a note about data presentation techniques

b. Mini Project:
concept of frequency tables and frequency curves

c. Other Activities(Specify):
Presentation on coefficient to variation

79EV304B.2: Introduce basic concepts useful for environmental data analysis

Approximate Hours

Item	Approx. Hrs.
Cl	15
LI	00
SW	03
SL	02
Total	20

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO2.1 Learn the concept of sampling **SO2.2** Know about types of sampling **SO2.3** Understand the concept of correlation and regression **SO2.4** Student will be able to understand about concept of testing of hypothesis **SO2.5** Learn the concept of Chi-square test		**Unit-2: Sampling** 2.1Concept of sampling 2.2 types of sampling 2.3 simple random 2.4 random sampling and stratified random sampling-1 2.5 random sampling and stratified random sampling-2 2.6 Correlation and regression 2.7 concept of testing of hypothesis 2.8 tests for single mean and difference of means 2.9 tests for single mean and difference of means 2.10 Chi-square test 2.11 students t-test 2.12 F-test 2.13 ANOVA 2.14 Tutorial-1 2.15 Tutorial-2	a. Concept of sampling. b. Concept of testing and hypothesis.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

Describe the concept of random sampling and stratified random sampling

b. Mini Project:

Write a report ontests for single mean and difference of means

c. Other Activities (Specify):

Concept of students t-test

79EV304B.3: Analyse, model and quantify uncertainty and variability in environmental data.

Approximate Hours

Item	Approx. Hrs.

Cl	10
LI	00
SW	03
SL	02
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO3.1 Know the concept of epidemiological study **SO3.2**Learn the monitoring techniques with respect to arsenicosis **SO3.3**Understand the concept of vector borne disease.		**Unit-3: ESA** 3.1 Introduction to Environmental System analysis 3.2 Approaches to development of models 3.3 Approaches to development of models 3.4 linear, simple and multiple regression model-1 3.5 linear, simple and multiple regression model-2 3.6 validation and forecasting 3.7 weather forecasting 3.8 Tutorial-1 3.9 Tutorial-2 3.10 Tutorial-3	a. What is arsenicosis? b. What is flouorosis? .

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Environmental risk evaluation

b. Mini Project:
monitoring techniques with respect to Flouorosis

c. Other Activities(Specify):
About environmental risk management

79EV304B.4: Become aware of a wide range of applications of statistics in environmental modelling & management.

Approximate Hours

Item	Approx. Hrs.
Cl	11
LI	00
SW	03
SL	02
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning
SO4.1Learn about the basic concept of environmental health **SO4.2know about the relevant stresses** **SO4.3Understand the relationship of industrial toxicology with occupation and hygiene**		**Unit-4: Statistical Models** **4.1Models of population growth and interactions-1** **4.2 1Models of population growth and interactions-2** **4.3 Lotka – Voltrra model** **4.4 Leslie's matrixmodel** **4.5 point source stream pollution model** **4.6 Box model** **4.7 Gaussian plume model** **4.8Gaussian plume model** **4.9 prey-predator model** **4.10 Tutorial-1** **4.11 Tutorial-2**	a. **Environmental health** b. **Industrial toxicology**

SW-4 Suggested Sessional Work (SW):

a. Assignments:
Physiological responses of man to relevant stresses in the environment

b. Mini Project:
Make a PPT on industrial toxicology

c. Other Activities(Specify):
About diseases in relation to industrial toxicology

79EV304B.5: Develop technical skills to use statistical tools and software in environmental data analysis

Approximate Hours

Item	Approx. Hrs.
Cl	11
LI	00
SW	03
SL	02
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL**
SO5.1know about the basic principles of occupational health. **SO5.2**understand diseases related to occupation **SO5.3**Describe the hygiene relationships with regards to the occupation		**Unit-5: Computers & Software** 5.1 computer applications 5.2 Structure 5.3 Function 5.4 capabilities and limitations of computer 5.5 capabilities and limitations of computer 5.6 Computer packages 5.7 applications of computer in environmental science 5.8 Ecological modeling using computer softwares	a. What is occupational health? b. Health and safety problems in the working and living environment

		5.9 Software for statistical analysis; MS-Excel, SPSS, MiniTab, Sigmaplot,Statistica 5.10 Tutorial-1 5.11 Tutorial-2	

SW- 5 Suggested Sessional Work (SW):

d. Assignments:

Recommendations regarding health and safety problems in the working and living environment.

e. Mini Project:

Report on safety and diseases regarding the occupation

f. Other Activities(Specify):

Presentation onbasic principles of occupational health

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning(Sl)	Total hour (Cl+LI+SW+Sl)
79EV304B.1: Develop an intuitive statistical sensefor inferring meaning out of data collected from different environmental matrices	13	0	3	2	18
79EV304B.2: Implement statistics for environmental monitoring and sampling	15	0	3	2	20

79EV304B.3: Analyse, model and quantify uncertainty and variability in environmental data	10	0	3	2	15
79EV304B.4: Extract information and draw scientific Inference from large amount of data collected to solve environmental problems	11	0	3	2	16
79EV304B.5: Apply statistical tools and software to analyze environmental data.	11	0	3	2	16
Total Hours	60	00	15	10	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Fundamental statistics	03	01	01	05
CO-2	Sampling	02	06	02	10
CO-3	ESA	03	07	05	15
CO-4	Statistical Models	-	10	05	15
CO-5	Computer & Software	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply
The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks .

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Roleplay
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(h) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Fundamental of applied statistics –	S.C. Gupta and V.K. Kappor	Goel Publishin g House,	
2	Elements of statistics Multivariance analysis-	Donald R. Byrkit Hunt and Shelly	Stanely Lewis Publishers	
3	Computerized aided environmental management.	S.A. Abbassi and F.I. Khan	Himalaya, Publishi ng House	
4	Computerized environmental	J. Hardstay	Books and Allied (P) LTD. Kolkata.	
5	Biostatistics	: M.P. Arora & P KMalhan	Himalya publication	

AKS UNIVERSITY

Faculty of life science and Technology
Department of Environmental Science
Curriculum of M.Sc. (Environmental Science) Program
(Revised as on 01 August 2023)

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science

Course Code: 79EV304B

Course Title: Environmental Statistics and Modeling

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for problems	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1. Develop an intuitive statistical sense for inferring meaning out of data collected from different environmental matrices	3	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1

CO 2: Implement statistics for environmental monitoring and sampling	**2**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Analyse, model and quantify uncertainty and variability in environmental data	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Extract information and draw scientific inference from large amount of data collected to solve environmental problems	**3**	**2**	**1**	**2**	**2**	**1**	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**2**	**2**
CO 5: Apply statistical tools and software to analyze environmental data.	**2**	**1**	**2**	**1**	**1**	**3**	**1**	**3**	**1**	**1**	**2**	**2**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO1. Develop an intuitive statistical sense for inferring meaning out of data collected from different environmental matrices	SO1.1SO1.2SO1.3 SO1.4 SO1.5	1.1,1.2,1.3,1.4,1.5,1.6, 1.7,1.8,1.9,1.10,1.11,1.12	**Unit-1**: **Fundamental statistics** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12,1.13	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Implement statistics for environmental monitoring and sampling	SO2.1SO2.2SO2.3 SO2.4 SO2.5		**Unit-2**: **Sampling** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.13,2.14,2.15	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Analyse, model and quantify uncertainty and variability in environmental data	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		**Unit-3**: **ESA** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Extract information and draw scientific inference from large amount of data collected to solve environmental problems	SO4.1SO4.2SO4.3 SO4.4 SO4.5	4.1,4.2,4.3	**Unit-4: Statistical Models** 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Apply statistical tools and software to analyze environmental data.	SO5.1SO5.2SO5.3 SO5.4 SO5.5		**Unit 5**: **Computers & Software** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8,5.9,5.10,5.11	

Semester-III

Course Code: **79EV351**

Course Title: **Practical Lab-1**

Pre- requisite: Student should have basic knowledge of Microbiology & Biotechnology.

Rationale: In an M.Sc. Environmental Science program, the inclusion of microbiology, biotechnology, paper writing, and biostatistics is pivotal for a holistic understanding of environmental issues and solutions. Microbiology allows students to explore the role of microorganisms in ecosystems, biogeochemical cycles, and environmental health, providing insights into pollution control and biodegradation processes. Biotechnology equips students with cutting-edge tools and techniques for environmental remediation, bioenergy production, and sustainable practices. Paper writing hones critical communication skills, essential for disseminating research findings and influencing policy decisions. Biostatistics offers robust methods for data analysis, helping students to design experiments, interpret complex datasets, and draw reliable conclusions, thereby underpinning all scientific inquiries in environmental science. Together, these disciplines foster a comprehensive and interdisciplinary approach, essential for addressing contemporary environmental challenges.

Course Outcomes:

79EV351.1: Gain hands-on experience with various microbiology and biotechnology instruments, understanding their working principles and applications in environmental science research.

79EV351.2: Develop skills in preparing microbiological media, performing sterilization, and executing techniques for inoculation, cultivation, isolation, and enumeration of microorganisms, crucial for environmental monitoring and bioremediation studies.

79EV351.3: Acquire the ability to calculate mean, mode, median, standard error, standard deviation, and the coefficient of correlation, using these statistical tools to analyze and interpret environmental data effectively.

79EV351.4: Proficient in scientific paper writing, understanding the format, requirements, and process of drafting, reviewing, and publishing research papers, thereby enhancing their ability to communicate scientific findings to the academic community and policymakers.

79EV351.5: Learn Gram staining of bacteria, enabling them to conduct genetic and phenotypic analyses of environmental samples, which is vital for biodiversity assessments and microbial ecology.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Laboratory course (PLC)	**79EV351**	**Practical Lab-1**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV++TA)		
PLC	79EV351	Practical Lab-1	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session

levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV351.1: Gain hands-on experience with various microbiology and biotechnology instruments, understanding their working principles and applications in environmental science research.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Understanding Laboratory Equipment, **SO1.2** Proficient Media Preparation. **SO1.3** Sterilization Techniques Mastery. **SO1.4** Practical Application of Lab Procedures. **SO1.5** Problem-Solving and Troubleshooting Skills.	**Unit-1** 1.1 Study the working principle of different instruments of Microbiology and Biotechnology lab-1 1.2 Study the working principle of different instruments of Microbiology and Biotechnology lab-2 1.3 Study the working principle of different instruments of Microbiology and Biotechnology lab-3 1.4 Study the working principle of different instruments of Microbiology and Biotechnology lab- 4 1.5 Study of general techniques of microbiology media preparation, Sterilization- 1		1.sterilization

	1.6 Study of general techniques of microbiology media preparation, Sterilization-2 1.7 Study of general techniques of microbiology media preparation, Sterilization-3 1.8 Study of general techniques of microbiology media preparation, Sterilization-4 1.9 Study of general techniques of microbiology media preparation, Sterilization-5		

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Identify and explain the working principles of key instruments used in microbiology and biotechnology laboratories, such as autoclaves, incubators, PCR machines, and spectrophotometers.

b. Mini Project:

i. Find out the frequency of plants by quadrate methods.

c. Other Activities (Specify):

Different sterilization techniques, such as autoclaving and filtration, ensuring an aseptic environment for microbial experiments and preventing contamination.

79EV351.2: Develop skills in preparing microbiological media, performing sterilization, and executing techniques for inoculation, cultivation, isolation, and enumeration of microorganisms, crucial for environmental monitoring and bioremediation studies.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 develop the ability to write scientific	**Unit-2**		1.Media preparation

papers. **SO2.2** Competence in Gram Staining **SO2.3** Analytical Skills in Biostatistics. **SO2.4** Effective Communication of Research Findings. **SO2.5** Mastery of Scientific Writing.	2.1 Inoculation, cultivation, isolation and enumeration of microorganisms- 1 2.2 Inoculation, cultivation, isolation and enumeration of microorganisms-2 2.3 Inoculation, cultivation, isolation and enumeration of microorganisms-3 2.4 Inoculation, cultivation, isolation and enumeration of microorganisms-4 2.5 Gram staining of bacteria-1 2.6 Gram staining of bacteria-2 2.7 Gram staining of bacteria. -3 2.8 Gram staining of bacteria- 4 2.9 Gram staining of bacteria-5		methods.

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Design experiments, collect data, and apply biostatistical methods to analyze and interpret data, enhancing their capacity to draw meaningful conclusions and make data-driven decisions in environmental research.

b. **Project:**
write scientific papers with proper structure, including abstract, introduction, methodology, results, discussion, and references, adhering to academic standards and formatting guidelines

c. **Other Activities (Specify):**
Design experiments, collect data, and apply biostatistical methods to analyze and interpret data, enhancing their capacity to draw meaningful conclusions and make data-driven decisions in environmental research.

79EV351.3: Acquire the ability to calculate mean, mode, median, standard error, standard deviation, and the coefficient of correlation, using these statistical tools to analyze and interpret environmental data effectively.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Demonstrate proficiency in aseptic techniques to prevent contamination during the isolation of soil bacteria. **SO3.2** Understand and apply serial dilution methods. **SO3.3** Identify different types of bacterial colonies based on morphological characteristics. **SO3.4** Perform quantitative analysis to calculate the colony-forming units (CFUs) per gram of soil, providing an estimate of bacterial abundance. **SO3.5** Interpret their findings in terms of fungal ecology.	**Unit-3** 3.1 Isolation and Enumeration of soil bacteria- 1 3.2 Isolation and Enumeration of soil bacteria- 2 3.3 Isolation and Enumeration of soil bacteria- 3 3.4 Isolation and Enumeration of soil bacteria- 4 3.5 Isolation and Enumeration of soil bacteria- 5 3.6 Isolation and Enumeration of Fungi – 1 3.7 Isolation and Enumeration of Fungi – 2 3.8 Isolation and Enumeration of Fungi – 3 3.9 Isolation and Enumeration of Fungi – 4		1. Characteristics of bacteria and fungi.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Discuss the role of fungi in soil ecosystems and factors affecting fungal populations.

b. Mini Project:

Identify different types of bacterial colonies based on morphological characteristics observed on agar plates.

c. Other Activities (Specify):

calculate the colony-forming units (CFUs) per gram of soil, providing an estimate of bacterial abundance.

79EV351.4: Proficient in scientific paper writing, understanding the format, requirements, and process of drafting, reviewing, and publishing research papers, thereby enhancing their ability to communicate scientific findings to the academic community and policymakers.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understanding the Principles of PCR. **SO4.2**. Hands-on Experience with PCR Technique **SO4.3** Data Collection and Organization. **SO4.4** Manual Calculation of Mean, Mode, and Median. **SO4.**5 Interpreting and Presenting Statistical Results.	**Unit-4** 4.1 DNA isolation through PCR – 1 4.2 DNA isolation through PCR – 1 4.3 DNA isolation through PCR – 1 4.4 DNA isolation through PCR – 1 4.5 DNA isolation through PCR – 5 4.6 Calculation of mean, mode, median of given data - 1 4.7 Calculation of mean, mode, median of given data - 2 4.8 Calculation of mean, mode, median of given data – 3 4.9 Calculation of mean, mode, median of given data - 4		1. What is PCR?

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Calculat the mean, mode, and median of a given dataset and understand the mathematical processes involved.

b. **Mini Project:**
Analyze the PCR products using gel electrophoresis and interpret the results.

79EV351.5: Learn Gram staining of bacteria, enabling them to conduct genetic and phenotypic analyses of environmental samples, which is vital for biodiversity assessments and microbial ecology.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 Understand how to assess and report the uncertainty in experimental measurements. **SO5.2**. Gain skills in interpreting the results of correlation. **SO5.3** Writing clearly and concisely, effectively communicating their research findings. **SO5.4** Apply statistical software to real-world environmental science problems, enhancing their practical data analysis capabilities. **SO5.5** Learn how to import, clean, and manage environmental datasets within the software.	**Unit-5** 5.1 Calculation of standard error & standard deviation-1 5.2 Calculation of standard error & standard deviation-2 5.3 Calculation of Coefficient of Correlation – 1 5.4 Calculation of Coefficient of Correlation – 2 5.5 Use of statistical software and their usage in environmental science data analysis – 1 5.6 Use of statistical software and their usage in		1.Basics of biostatistics.

	environmental science data analysis – 2 5.7 Paper Writing- Format, Requirements & Process-1 5.8 Paper Writing- Format, Requirements & Process-2 5.9 Paper Writing- Format, Requirements & Process-3		

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Calculate standard error and standard deviation from sample data.

b. **Mini Project:**
Apply your calculations to environmental science datasets, interpreting their significance in research.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV351.1: Gain hands-on experience with various microbiology and biotechnology instruments, understanding their working principles and applications in environmental science research.	0	18	2	1	12
79EV351.2: Develop skills in preparing microbiological media, performing sterilization, and executing techniques for inoculation, cultivation, isolation, and enumeration of microorganisms, crucial for environmental monitoring and bioremediation studies.	0	18	2	1	12
79EV351.3: Acquire the ability to calculate mean, mode, median, standard error, standard deviation, and the coefficient of correlation, using these statistical tools to analyze and interpret environmental data	0	18	2	1	12

effectively.					
79EV351.4: Proficient in scientific paper writing, understanding the format, requirements, and process of drafting, reviewing, and publishing research papers, thereby enhancing their ability to communicate scientific findings to the academic community and policymakers.	0	18	2	1	12
79EV351.5: Learn Gram staining of bacteria, enabling them to conduct genetic and phenotypic analyses of environmental samples, which is vital for biodiversity assessments and microbial ecology.	0	18	2	1	12
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10
CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method

4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Environmental Microbiology: A Laboratory Manual (Maier and Pepper Set)	Ian Pepper , Charles P. Gerba, Jeffrey W. Brendecke	Academic Press Inc	2nd, 2005
2	Microbiology Practical Manual	Amita Jain, Jyotsna Agarwal, Vimala Venkatesh	Elsevier India	1st , September 2018
3	Hand Book of Practical Microbiology	Dr.N.Murugesh , Dr.Akshay Chandra Deka, Dr.Vidhya Srinivasan	Sathya Publishers	30 November 2021
4	Environmental Microbiology: A Laboratory Manual	Ian L. Pepper, Charles P. Gerba, Jeffrey W. Brendecke	Academic Press,	1995

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV51
Course Title: Practical Lab – 1

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Gain hands-on experience with various microbiology and biotechnology instruments, understanding their working principles and applications in environmental science research.	3	2	2	2	1	2	3	3	2	2	2	2	1	1	2	2

CO 2: Develop skills in preparing microbiological media, performing sterilization, and executing techniques for inoculation, cultivation, isolation, and enumeration of microorganisms, crucial for environmental monitoring and bioremediation studies.	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**
CO3: Acquire the ability to calculate mean, mode, median, standard error, standard deviation, and the coefficient of correlation, using these statistical tools to analyze and interpret environmental data effectively.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Proficient in scientific paper writing, understanding the format, requirements, and process of drafting, reviewing, and publishing research papers, thereby enhancing their ability to communicate scientific findings to the academic community and policymakers.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**

CO 5 Learn Gram staining of bacteria, enabling them to conduct genetic and phenotypic analyses of environmental samples, which is vital for biodiversity assessments and microbial ecology.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Develop skills in auditing and evaluating environmental performance in compliance with ISO standards.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		As mentioned in

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3 Understand the relationship between socio-economic factors and environmental conditions.	SO3.1SO 3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.	SO4.1SO 4.2SO4.3 SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Enhance the ability to use socio-economic data to inform environmental planning and decision-making.	SO5.1SO 5.2SO5.3 SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

Semester-III

Course Code: **79EV352**

Course Title: **Practical Lab-2**

Pre- requisite: Student should have basic knowledge of Disaster management & Environmental law.

Rationale: In an M.Sc. Environmental Science course, these experiments and studies provide a comprehensive understanding of various critical environmental and social issues. Calculating the carbon footprint of anthropogenic activities offers insights into human impact on climate change. Exploring women's health and child labor in India highlights socio-economic and environmental interactions. The case study of Delhi delves into urban environmental challenges. Examining farmer suicides addresses the interplay of environmental, economic, and social factors. Resettlement and rehabilitation issues focus on the human dimensions of environmental policies. Risk identification for earthquakes and floods enhances disaster preparedness.

Course Outcomes:

79EV352.1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.

79EV352.2: Develop skills in auditing and evaluating environmental performance in compliance with ISO standards.

79EV352.3: Understand the relationship between socio-economic factors and environmental conditions.

79EV352.4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.

79EV352.5: Enhance the ability to use socio-economic data to inform environmental planning and decision-making.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Laboratory course (PLC)	**79EV352**	**Practical Lab-2**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 7 marks each (HA)	Viva-Voce 2, 5 marks each (VV)	Class Attendance (TA)	Total Mark (HA+VV+ +TA)		
PLC	**79EV352**	**Practical Lab-2**	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV352.1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Apply carbon footprint calculation methods and tools. **SO1.2** Evaluate the environmental impact of these activities and propose reduction strategies. **SO1.3** Analyze data related to women's health and child labor. **SO1.4** Evaluate the effectiveness of current policies and measures addressing these environmental issues. **SO1.5** Assess the impacts of environmental factors on women's health and child labor.	**Unit-1** 1.1 Calculation of the carbon footprint of some anthropogenic activities – 1 1.2 Calculation of the carbon footprint of some anthropogenic activities – 2 1.3 Calculation of the carbon footprint of some anthropogenic activities – 3 1.4 Study of Women Health & Child Labor in India – 1 1.5 Study of Women Health & Child Labor in India – 2 1.6 Study of Women Health & Child Labor in India – 3 1.7 Study of Environmental issues in India- Delhi case study – 1 1.8 Study of Environmental issues in India- Delhi case study – 2 1.9 Study of Environmental issues in India- Delhi case study – 3		1. What do you mean by carbon foot print.

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
Identify and list major anthropogenic activities contributing to carbon emissions.

b. **Mini Project:**
Collect and analyze data related to women's health and child labor.

c. **Other Activities (Specify):**
Evaluate the effectiveness of current policies and measures addressing these environmental issues.

79EV352.2: Develop skills in auditing and evaluating environmental performance in compliance with ISO standards.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Understand the socio-economic factors contributing to farmer suicides in India. **SO2.2** Analyze the socio-economic and cultural impacts of displacement on affected populations. **SO2.3** Propose policy recommendations to ensure equitable and sustainable resettlement and rehabilitation practices. **SO2.4** Enhance the ability to work collaboratively with various stakeholders	**Unit-2** 2.1 Suicides of Farmers- Case study of a serious social issue – 1 2.2 Suicides of Farmers- Case study of a serious social issue – 2 2.3 Suicides of Farmers- Case study of a serious social issue – 3 2.4 Resettlement & Rehabilitation issues & R&R Policy in India – 1 2.5 Resettlement & Rehabilitation issues & R&R Policy in India – 2 2.6 Resettlement & Rehabilitation issues & R&R Policy in India – 3 2.7 Risk identification, assessment &		Rehabilitation policy of India

in disaster preparedness and response efforts. **SO2.**5 Learn to create and implement effective disaster management and mitigation plans.	management of Earthquakes & Flood-1 2.8 Risk identification, assessment & management of Earthquakes & Flood-2 2.9 Risk identification, assessment & management of Earthquakes & Flood-3		

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
Describe the socio-economic factors contributing to farmer suicides in India.

b. **Project:**
Create and implement effective disaster management and mitigation plans.

c. **Other Activities (Specify):**
Discuss the complexities and challenges involved in resettlement and rehabilitation processes.

79EV352.3: Understand the relationship between socio-economic factors and environmental conditions.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Learn about various rainwater harvesting techniques and their applications in different environments. **SO3.2** Understand the principles and requirements of ISO 14000 environmental management standards. **SO3.3** Learn about risk identification,	**Unit-3** 3.1 Preparation of different models for rain water harvesting – 1 3.2 Preparation of different models for rain water harvesting – 2 3.3 Preparation of different models for rain water harvesting – 3 3.4 Study of environmental management system (ISO		1. Modals of rain water harvesting.

assessment, and management strategies for various types of urban disasters. **SO3.4** Able to promote the adoption of ISO 14000 standards to improve environmental performance. **SO3.5** Equipped to promote and implement rainwater harvesting practices in their communities and institutions.	14000) in industries – 1 3.5 Study of environmental management system (ISO 14000) in industries – 2 3.6 Study of environmental management system (ISO 14000) in industries – 3 3.7 Visit to Disaster Management Cell in urban area for the following disaster – 1 3.8 Visit to Disaster Management Cell in urban area for the following disaster – 2 3.9 Visit to Disaster Management Cell in urban area for the following disaster – 3		

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
Describe various rainwater harvesting techniques and their applications in different environments.

b. **Mini Project:**
Identify different types of bacterial colonies based on morphological characteristics observed on agar plates.

c. **Other Activities (Specify):**
Discuss the principles and requirements of ISO 14000 environmental management standards.

79EV352.4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Develop the ability to extract, analyze, and interpret socio-economic data from census reports, enhancing their quantitative research skills. **SO4.2** Understand the historical and socio-political context of S.C. Mehta's environmental activism. **SO4.3** Identify and describe notable green buildings in India and around the world. **SO4.4** Identify and advocate for best practices in green building construction and maintenance. **SO4.**5 Develop critical thinking skills by analyzing the challenges and successes of S.C. Mehta's campaigns against pollution.	**Unit-4** 4.1 Study of socio-economy of an area with the help of Census data – 1 4.2 Study of socio-economy of an area with the help of Census data – 2 4.3 Study of socio-economy of an area with the help of Census data – 3 4.4 S.C Mehta (Goldman Environmental Prize winner) & His Fights against Pollution – 1 4.5 S.C Mehta (Goldman Environmental Prize winner) & His Fights against Pollution – 2 4.6 S.C Mehta (Goldman Environmental Prize winner) & His Fights against Pollution – 3 4.7 Enlist various green buildings in India and world – 1 4.8 Enlist various green buildings in India and world – 2 4.9 Enlist various green buildings in India and world – 3		1. Case studies of S. C. Mehta.

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
Elaborate principles and features of green buildings, including their environmental benefits.

b. **Mini Project:**
Write about sustainability and energy efficiency of different green building designs.

79EV352.5: Enhance the ability to use socio-economic data to inform environmental planning and decision-making.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	18
SW	2
SL	1
Total	21

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Analyze and evaluate the market for environmentally sound products. **SO5.2**. Identify and analyze best practices in environmental management adopted by different industries. **SO5.3** Develop skills in conducting risk assessments and identifying potential hazards in the workplace. **SO5.4** Learn about the essential components of a first aid kit and how to prepare and maintain one. **SO5.5** Acquire fundamental knowledge and skills in first aid, including how to respond to common injuries and emergencies.	**Unit-5** 5.1 Survey of market for environmental sound products (eco-labelling) - 1 5.2 Survey of market for environmental sound products (eco-labelling) – 2 5.3 Study of environmental management practices in industries – 1 5.4 Study of environmental management practices in industries – 2 5.5 PPEs & Safety Protocols in various Industries in India – 1 5.6 PPEs & Safety Protocols in various Industries in India – 2 5.7 First Aid preparation- Importance & requirements - 1 5.8 First Aid preparation- Importance & requirements - 2 5.9 First Aid preparation- Importance & requirements - 3		1. First aid

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Importance of regular first aid training and preparedness in ensuring readiness to handle emergencies in various settings, including workplaces and public areas.

b. **Mini Project:**
Different types of personal protective equipment (PPE) used in various industries and their specific applications.

Brief of Hours suggested for the Course Outcome

Course Outcome	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV352.1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.	0	18	2	1	12
79EV352.2: Develop skills in auditing and evaluating environmental performance in compliance with ISO standards.	0	18	2	1	12
79EV352.3: Understand the relationship between socio-economic factors and environmental conditions.	0	18	2	1	12
79EV352.4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.	0	18	2	1	12
79EV352.5: Enhance the ability to use socio-economic data to inform environmental planning and decision-making.	0	18	2	1	12
Total Hours	0	90	10	5	105

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Unit -1	03	04	03	10
CO-2	Unit -2	03	04	03	10
CO-3	Unit 3	03	04	03	10
CO-4	Unit 4	03	04	03	10
CO-5	Unit 5	04	04	02	10
Total		16	20	14	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Practical Lab – 1 will be held with written examination of 50 marks **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	Environmental Education and Awareness Manual	Michael Nwachukwu LAP LAMBERT	Academic Publishing	2014
2	Practical Guide to Industrial Safety: Methods for Process Safety	Nicholas P. Cheremisinoff	CRC Press	2019

	Professionals			
3	LAB SAFETY MANUAL Safety and Emergency Protocols	Laboratory Safety Committee LASAC	CSIR-Central Electrochemical Research Institute Karaikudi	2022
4	Handbook of Environmental Impact Assessment Concepts and Practice	Arjun Kumar A. Rathi	Cambridge Scholars Publishing	2021

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV252
Course Title: Practical Lab – 2

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Develop skills in auditing and evaluating environmental	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

performance in compliance with ISO standards.																
CO3: Understand the relationship between socio-economic factors and environmental conditions.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO 5 Enhance the ability to use socio-economic data to inform environmental planning and decision-making.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Develop an understanding of the methodology for calculating carbon footprints, including data collection and analysis.	SO1.1, SO1.2, SO1.3, SO1.4, SO1.5	Unit-1 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9		As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Develop skills in auditing and evaluating environmental performance in compliance with ISO standards.	SO2.1, SO2.2, SO2.3, SO2.4, SO2.5	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6, 2.7,2.8,2.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Understand the relationship between socio-economic factors and environmental conditions.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5	Unit-3: 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Promote the adoption of ISO 14000 standards to improve environmental performance and regulatory compliance.	SO4.1SO4.2SO4.3SO4.4 SO4.5	Unit-4: 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9		
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Enhance the ability to use socio-economic data to inform environmental planning and decision-making.	SO5.1SO5.2SO5.3SO5.4 SO5.5	Unit 5: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9		

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester III

Course Code: 79EV353

Course Title: Industrial visit/Field work/
Educational tour

Pre- requisite: Basic Knowledge of Environmental Biotechnology & microbiology, Environmental Law, Disaster management & research & paper writing.

Rationale: The objectives of the Industrial Training include: To give students the opportunity to apply the knowledge and skills they have acquired on campus in a real-life work situation. To provide students with opportunities for practical, hands-on learning from practitioners in the student's areas of specialization. To expose students to a work environment, common practices, employment opportunities and work ethics in their relevant field. To enhance the employability skills of the students. To provide opportunities for students to be offered jobs in the organizations in which they undergo their Industrial Training.

Course Outcomes:

79EV353.1: Apply theoretical concepts learned in the classroom to real-world environmental issues and scenarios.
79EV353.2: Develop improved analytical and observational skills by examining environmental processes and conducting on-site data collection and analysis.
79EV353.3: Gain insights into various industrial processes and their environmental impacts, as well as the methods used for pollution control and sustainable practices.
79EV353.4: Introduced to modern environmental technologies and practices used in the field, enhancing their knowledge of current industry standards and innovations.
79EV353.4: Opportunity to interact with industry professionals, fostering connections that could lead to future internships, research collaborations, or job opportunities.

Scheme of Studies:

Course Category	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
P_fCC	79EV353	Industrial visit/Field work/ Educational tour	0	0	0	0	4	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Industrial visit/Field work/ Educational tour

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)			
			End Semester Assessment (ESA)			
			Field Report	Presentation	Viva - Voce	Total Marks
P_fCC	79EV353	Industrial visit/Field work/ Educational tour	40	20	40	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Guidelines for Project work

To provide hands on training expertise in research, field-work/industrial visit will be allotted to students of 2nd semester. The field site/ Industry can be selected and carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their report in the department as per the date announced for the submission.
Assessment of the Report will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates.

- The paper size to be used should be A-4 size.
- The font size should be12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and half) space

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science

5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV353
Course Title: Industrial visit/Field work/ Educational tour

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Apply theoretical concepts learned in the classroom to real-world environmental issues and scenarios.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Develop improved analytical and observational skills by examining environmental processes and	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

conducting on-site data collection and analysis.																
CO3: Gain insights into various industrial processes and their environmental impacts, as well as the methods used for pollution control and sustainable practices.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Introduced to modern environmental technologies and practices used in the field, enhancing their knowledge of current industry standards and innovations.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO5: opportunity to interact with industry professionals, fostering connections that could lead to future internships, research collaborations, or job opportunities.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester-IV

Course Code: 79EV401

Course Title: Industrial Safety & Hygiene

Pre- requisite: Student should have basic knowledge of industrial environment.

Rationale: The students studying Environmental Science should possess foundational understanding about environment. Environment, health and safety (EHS) is the set that studies and implements the practical aspects of protecting the environment and maintaining health and safety at occupation.

Course Outcomes:

79EV 401.1: Apply fundamentals of industrial safety.

79EV401.2: Know about acts and rules related to safety.

79EV401.3: Practice first aid during industrial accidents.

79EV401.4: Analyse risk reduction strategies.

79EV401.5: Implement industrial best practices.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	79EV401	Industrial Safety & Hygiene	3+1	0	1	1	5	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	79EV401		15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV401.1: Apply fundamentals of industrial safety.

Approximate Hours

Item	AppX Hrs.
Cl	13
LI	0
SW	3
SL	1
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO1.1 Understand the concept of safety. SO1.2 Learn about safety acts and rules. SO1.3 Describe safety standards and codes. SO1.4 Know the responsibilities of employer and employee SO1.5 Know the requirements of record keeping.		**Unit-1 Introduction** 1.1 Need for safety 1.2 Safety legislation **1.3** Safety acts and rules. **1.4 Tutorial 1** **1.5** Safety standards and codes, **1.6** Safety policy. **1.7** safety organization and responsibilities. **1.8** Responsibilities of employer and employee **1.9 Tutorial 2** 1.10 Requirements of record keeping & reporting 1.11 Importance of industrial safety & safety organizations 1.12 Responsibilities of safety officer, supervisors & safety committees. 1.13 Tutorial 3	1. What is safety and requirement of safety in industries.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Write about the importance of industrial safety & safety organizations.

ii. Describe the responsibilities of safety officer, supervisors & safety committees.

iii. Write the safety measures required for the organization.

b. Mini Project:

i. Requirements of record keeping & reporting

c. Other Activities (Specify):

Study about the responsibilities of safety officer, supervisors & safety committees in industries.

79EV 401.2: Know about the acts and rules related to safety.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	2
SL	1
Total	14

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Understand central acts. **SO2.2** Learn about the Construction Safety Regulations. **SO2.3** Know Functions of National Safety Council. **SO2.4** Understand the Petroleum Rules 2002. **SO2.**5 Learn about the Factories act.		Unit-2 **Acts & Rules** 2.1 Central acts-1 2.2 Central acts-1 2.3 Tutorial 1 2.4 Construction Safety Regulations 2.5 Petroleum Rules 2002. 2.6 Electrical Act & Rules 2.7 Tutorial 2 2.8 History & Provisions under the factories Act and rules made there under with amendments -1 2.9 History & Provisions under the factories Act and rules made there under with amendments -1 2.10 Functions of National Safety Council. 2.11 Tutorial 3	i. History of factory act

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Construction and safety regulation act.
ii. Describe the Petroleum rules 2002
iii. What do you mean by Electrical Act & Rules? Explain.
iv. Describe Provisions under the factories Act and rules made there under with amendments.

b. Mini Project:

Make a report on Functions of National Safety Council.

79EV401.3: Practice first aid during industrial accidents.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Know the causes of industrial accident. **SO3.2** Understand effects of industrial accident. **SO3.3** Describe accident prevention techniques. **SO3.4** Understand impacts of accidents on employees. **SO3.**5 Learn the responsibilities of management in preventing accidents.		**Unit-3: Industrial Accidents** 3.1 Causes of industrial accident 3.2 Effects of industrial accident 3.3 Accident prevention and control techniques 3.4 Tutorial 1 3.5 Cost of accidents 3.6 Impacts of accidents on employees 3.7 Role and responsibilities of union in preventing accidents 3.8 Tutorial 2 3.9 Role and responsibilities of management in preventing accidents 3.10 Role and responsibilities of society in preventing accidents 3.11 first aid- a basic concept. 3.12 Tutorial 3	i. What is accident.? ii. Causes of accidents in industries.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Impacts of accidents on employees
ii. Role and responsibilities of society in preventing accidents
iii. Role and responsibilities of management in preventing accidents

b. Mini Project:

First aid- a basic concept.

c. Other Activities (Specify):

Make a report on causes and effects of accidents in industries

79EV 401.4: Analyze risk reduction strategies.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	3
SL	2
Total	17

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understanding the risk reduction strategies. **SO4.2** Identify potential safety and health hazards in industries. **SO4.3** Know occupational safety. **SO4.4** Know EPA standard. **SO4.**5 Understand performance measurements to determine effectiveness of PSM.	.	**Unit-4: Safety & Health Hazards** 4.1 Identification of potential safety and health hazards in industrial and development projects-1 4.2 Identification of potential safety and health hazards in industrial and development projects-1 4.3 Risk reduction strategies 4.4 Tutorial 1 4.5 Occupational safety Process Safety Management (PSM) as per OSHA 4.6 Process Safety Management (PSM) as per PSM principles 4.7 Tutorial 2 4.8 OHSAS–18001 4.9 EPA Standards 4.10 Performance Measurements to determine effectiveness of PSM-1 4.11Performance measurements to determine effectiveness of PSM-1	i. Importance of safety. ii. What is hazard?

		4.12 Tutorial 3	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Process Safety Management (PSM) as per PSM principles.

ii. Describe EPA standards.

iii. Describe the methods of performance measurements to determine effectiveness of PSM.

b. Mini Project:

i. Visit to nearest industry and identify health hazard.

c. Other Activities (Specify):

Power Point Presentation on Risk reduction strategies

79EV401. 5: Implement industrial best practices.

Item	AppX Hrs
Cl	08
LI	0
SW	2
SL	2
Total	12

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO5.1 understand IBP$_s$ in electrical **SO5.2** Know the Personal Protective Equipment **SO5.3** Learn IBP$_s$ in fire & machine guarding **SO5.4 know** Ergonomics of ambulance **SO5.**5 Learn Management of contractors		**Unit 5: Industrial Best Practices (IBP$_s$)** in electrical in mechanical in fire & machine guarding **rial 1** nal Protective Equipment iratory and non-respiratory) -1 nal Protective Equipment iratory and non-respiratory) -1 upational health -1 pational health -1 ial 2 nomics of ambulance agement of contractors rial 3	1.industrial best practices for safety. 2. what is PPE?

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. IBP$_s$ in electrical,
ii. IBP$_s$ mechanical,
iii. IBP$_s$ fire & machine guarding
iv. What is Occupational Health

b. Mini Project:

Make the list of Personal Protective Equipment (respiratory and non-respiratory) used in industry.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV 401.1: Apply fundamentals of industrial safety.	13	3	2	18
79EV 401.2: Know about acts and rules related to safety.	11	3	2	16
79EV 401.3: Practice first aid during industrial accidents.	12	3	2	17

79EV 401.4**:** Analyze risk reduction strategies.	12	3	2	17
79EV 401.5: Implement industrial best practices.	12	3	2	17
Total Hours	60	15	10	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Acts & Rules**	02	06	02	10
CO-3	**Industrial Accidents**	03	07	05	15
CO-4	Safety & Health Hazards	-	10	05	15
CO-5	**Industrial Best Practices (IBP_s)**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)

9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Industrial Safety, Health and Environment Management Systems	R.K. Jain and Sunil S. Rao	Khanna publishers, New Delhi	2006
2	Hand book of Occupational Safety and Health	Slote. L, John Willey and Sons	New York	2019
3	Industrial Safety, Health and Environment Management Systems	R. K. Jain and Sunil S. Rao	Khanna publishers, New Delhi	2006
4	The Factories Act with amendments1987		Govt. of India Publications DGFASLI, Mumbai.	

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV401
Course Title: Industrial Safety & Hygiene

Course Outcomes	**Program Outcomes**												**Program Specific Outcome**			
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	**Planning abilities**	**Problem analysis**	**Design/development of solution for**	**Modern tool usage**	**Leadership skills**	**Professional Identity**	**Environmental Ethics**	**Communication**	**The Environment and society**	**Environment and sustainability**	**Life-long learning**	**Proficiency in Environmental Analysis and Assessment**	**Application of Multidisciplinary Approaches**	**Critical Thinking and Problem-Solving Skills**	**Professional Ethics and Social Responsibility**
CO1: Apply fundamentals of industrial safety.	**1**	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
CO 2: Know about acts and rules related to safety.	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**
CO3: Practice first aid during industrial accidents.	**2**	**1**	**3**	**3**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CO 4: Analyse risk reduction strategies.	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**

CO 5: Implement industrial best practices.	-	**2**	**2**	**2**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Apply fundamentals of industrial safety.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1.0 **Introduction** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12,1.13	As mentioned in page number ……..
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Know about acts and rules related to safety.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Acts & Rules** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Practice first aid during industrial accidents.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: **Industrial Accidents** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.11,3.12	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Analyse risk reduction strategies.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Safety & Health Hazards** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11,4.12	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Implement industrial best practices.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **Industrial Best Practices (IBPs)** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Course Code: 79EV402A

Course Title: EIA & EMS

Pre- requisite: Student should have basic knowledge about impact of various factors on environment.

Rationale: The students studying Environmental Science should possess foundational understanding about impact of human activity on environment. The purpose of EIA is to ensure the protection and conservation of the environment and natural resources including human health aspects against uncontrolled development.

Course Outcomes:

79EV 402A.1: Describe Scope of Environmental Impact Assessment and its Objectives.

79EV402A.2: Discuss various approaches for various environmental impact studies.

79EV402A.3: Illustrate various steps of Environmental Impact Assessment and its methodologies.

79EV402A.4: Construct Environmental Impact Assessment plan for Industrial projects.

79EV402A.5: Learn Environmental Quality management.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credit (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PEC)	79EV402A	EIA & EMS	3+1	0	1	1	5	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PEC	79EV402A	EIA & EMS	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV402A.1: Describe Scope of Environmental Impact Assessment and its Objectives.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	02
SL	02

Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Aware with EIA. **SO1.2** Know the concepts of EIA. **SO1.3** Describe the legislative framework of EIA. **SO1.4** Learn the basic concept of Central appraisal committees. **SO1.**5 Know the Notification of MoEFCC.		**Unit-1 Introduction** **1.1** Concept of EIA. **1.2** Scope of EIA. **1.3** Principles of EIA**.** **1.4 Tutorial 1** **1.5** Salient features of EIA. **1.6** Legislative framework for EIA. **1.7** Guidelines of MoEFCC. **1.8 Tutorial 2** 1.9 Notification of MoEFCC. 1.10 Basic concept of Central appraisal committees. 1.11 Basic concept of State appraisal committees. 1.12 Tutorial 3	**1.** Effects of different industries on environment. 2. What is assessment?

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Write the concept of EIA.

ii. Describe the scope of EIA.

iii. Describe basic concept of Central appraisal committees.

iv. Mention the salient features of EIA.

b. Other Activities (Specify):

Presentation on legislative framework for EIA.

79EV 402A.2: Discuss various approaches for various environmental impact studies.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	3
SL	2
Total	18

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Learn the process for preparing environmental impact statements. **SO2.2** Understand the process for preparing public participation. **SO2.3** Know environmental audit (EA). **SO2.4** Know the benefits of environmental Audit (EA). **SO2.**5 Learn the procedure of environmental audit.		Unit-2 **EIS & EA** 2.1 Process for preparing Environmental Impact Statement (EIS). 2.2 Process for preparing public participation 2.3 Introduction of environmental Audit (EA) 2.4 Tutorial 1 2.5 Objectives of environmental audit. 2.6 Benefits of environmental audit. 2.7 Procedure of environmental audit. 2.8 Tutorial 2 2.9 Guidelines of EA-1 2.10 Guidelines of EA-2 2.11 Restoration technologies. 2.12 Rehabilitation technologies. 2.13 Tutorial 3	i.What is auditing? ii. Need of auditing.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Describe process for preparing Environmental Impact Statement (EIS).
ii. Discuss the guidelines of Environmental Audit.
iii. Throw light on the procedure of environmental audit.
iv. What is public participation? Describe the process for preparing public participation.

b. Mini Project:

Prepare a sample auditing report.

c. Other Activities (Specify):

Make a presentation on process for preparing Environmental Impact Statement (EIS).

79EV402A.3: Illustrate various steps of Environmental Impact Assessment and its methodologies.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Learn the methods of EIA. **SO3.2 Understand resource analysis** **SO3.3** Prepare impact assessment report **SO3.4** Learn impact of cement plants **SO3.**5 Learn assessment of mining area.		**Unit-3: Methods of EIA** Impact assessment methodologies-1 Impact assessment methodologies-2 Tutorial 1 Generalized approach to impact analysis. Resource analysis Baseline information Tutorial 2 Case studies of cement industry Case studies of thermal power plant) Case studies of mining area.	i. Need of EIA ii. Importance of EIA

		1 Tutorial 3	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the methods of impact assessment.
ii. Mention the impact of cement industry on environment and society
iii. The generalized approach to impact analysis.

b. Mini Project:

Prepare a report on impact assessment of mining area.

c. Other Activities (Specify):

Visit to thermal power plant/cement plant/mining area and analyze the impacts.

79EV 402A.4: Construct Environmental Impact Assessment plan for Industrial projects.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	2
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Learn about environmental site clearance. **SO4.2** Know the classification of industries. **SO4.3 Understand the methods of site selection**		**Unit-4: Operational Aspects of EIA** 4.1 Introduction 4.2 Environmental site clearance 4.3 Classification of industries 4.4 Site selection	i. What is clearance? ii. What is the importance of clearance in industries?

SO4.4 Know the importance of public consultation. **SO4.**5 Learn decision making.		4.5 Environmental clearance 4.6 Guidelines for industries 4.7 Screening 4.8 Scoping 4.9 Public consultation 4.10 Appraisal 4.11 Decision making 4.12 Post-clearance monitoring protocol.	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Classification of industries.
ii. Post-clearance monitoring protocol.
iii. What do you mean by decision making describe.
iv. Describe briefly post-clearance monitoring protocol.

79EV 402A.5: Learn Environmental Quality management.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 Understand environmental management plan		**Unit-5: EMP & Quality Management** 5.1 Fundamentals of EMP	i. What is environmental management?

(EMP) **SO5.2** Know the 12 steps to heaven. **SO5.3** Learn the Environmental management in industries. **SO5.4** Describe the rural environmental problems & solutions **SO5.**5 Understand eco planning.		5.2 Strategies 5.3 Objectives 5.4 12 steps to heaven 5.5 Environmental management in industries 5.6 Industrial estate planning 5.7 Urbanization & municipal environmental issues 5.8 Rural environmental problems & solutions 5.9 Introduction to ISO 9000 5.10Introduction to ISO 14000 5.11Introduction to Eco planning 5.12Tutorial 1	

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

i. Write the Strategies & Objectives of environmental management plan.
ii. Discuss about the environmental management in industries
iii. What do you mean by eco planning describe.
iv. Write a detail note on rural environmental problems & their solutions.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV 402A.1: Describe Scope of Environmental Impact Assessment and its Objectives.	12	2	2	16
79EV 402A.2: Discuss various approaches for various environmental impact studies.	13	3	2	18

79EV 402A.3: Illustrate various steps of Environmental Impact Assessment and its methodologies.	11	3	2	16
79EV 402A.4**:** Construct Environmental Impact Assessment plan for Industrial projects.	12	1	2	15
79EV 402A.5: Learn Environmental Quality management.	12	1	1	14
Total Hours	60	10	9	79

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Introduction**	03	01	01	05
CO-2	**EIS & EA**	02	06	02	10
CO-3	**Methods of EIA**	03	07	05	15
CO-4	**Operational Aspects of EIA**	-	10	05	15
CO-5	**EMP & Quality Management**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture

2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Environmental Impact Assessment: Principles and Procedures	R. K. Morgan	John Wiley and Sons, New York	2016
2	Environmental Impact Assessment	S.A. Abbasi & D.S. Arya	Discovery Publishing House, New Delhi.	2020
3	An Introduction to Environmental Management	Dr. Anand S. BAL	Himalaya Publishing House, New Delhi.	2009
4	Environmental Impact Analysis Handbook	John G.R. and David C. Wooten	McGraw Hill Publications	1987
5	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV402A
Course Title: EIA & EMS

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Describe Scope of Environmental Impact Assessment and its Objectives.	2	3	2	2	3	2	3	2	2	1	3	2	2	3	3	3
CO 2: Discuss various approaches for various environmental impact studies.	2	2	3	2	1	2	3	2	1	1	2	2	2	2	2	2
CO3: Illustrate various steps of Environmental Impact Assessment and its methodologies.	2	2	3	1	1	2	2	2	1	2	1	2	1	3	2	2
CO4: Construct Environmental Impact Assessment plan for Industrial projects.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	1

CO 5: Learn Environmental Quality management.	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**2**

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Describe Scope of Environmental Impact Assessment and its Objectives.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1 **Introduction** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Discuss various approaches for various environmental impact studies.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **EIS & EA** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11,2.12,2.13	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Illustrate various steps of Environmental Impact Assessment and its methodologies.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: **Methods of EIA** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Construct Environmental Impact Assessment plan for Industrial projects.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Operational Aspects of EIA** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11,4.12	

PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Learn Environmental Quality management.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **EMP & Quality Management** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Course Code:	79EV402B
Course Title:	Environmental Economics
Pre- requisite:	Student should have basic knowledge about natural resources and their economic value.
Rationale:	The students studying Environmental Science should possess foundational understanding about Environmental economics. Environmental economics focuses on how they use and manage finite resources in a manner that serves the population while meeting concerns about environmental impact. This helps governments weigh the pros and cons of alternative measures and design appropriate environmental policies.

Course Outcomes:

79EV 402B.1: Develop an intuitive capability to understand environmental economics concepts.

79EV402B.2: Implement tool of economic analysis of natural resources.

79EV402B.3: Analyze, environmental benefits assets.

79EV402B.4: Explain the techniques of carbon trading and cdm.

79EV402B.5: Analysis of environment trade and accounting.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PEC)	79EV402B	Environmental Economics	3+1	0	1	1	5	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ESA)
PEC	79EV402B	Environmental Economics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

79EV402B.1: Develop an intuitive capability to understand environmental economics concepts.

Approximate Hours

Item	AppX Hrs
Cl	10
LI	0
SW	1
SL	1
Total	12

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Learn concept of environmental economics. **SO1.2** Know the economy and the environment. **SO1.3** Understand Cost effectiveness analysis. **SO1.4** Describe cost-benefit analysis. **SO1.**5 Learn importance of environmental economics.		**Unit-1 Fundamental** **1.1** Concept of environmental economics **1.2** The economy and the environment -1 1.3 The economy and the environment -2 1.4 Tutorial 1 1.5 Cost effectiveness analysis -1 1.6 Cost effectiveness analysis -2 1.7 Tutorial 2 1.8 cost-benefit analysis -1 1.9 cost-benefit analysis-2 1.10 Tutorial 3	1. What is environmental economics.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the concept of environmental economics.

ii. What do you mean by economy and the environment? explain.

iii. Discuss cost effectiveness analysis.

iv. Describe cost-benefit analysis.

79EV 402B.2: Implement tool of economic analysis of natural resources.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	01
SL	02
Total	14

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Know the tools of economics. **SO2.2** Learn national resource economics **SO2.3** Understand analytical tools. **SO2.4 Describe supply and demand.** **SO2.**5 Understand accountings of naturals assets.		Unit-2 **Tools of Economics** 2.1 National resource economics – 1 2.2 National resource economics – 2 2.3 National resource economics – 3 2.4 Tutorial 1 2.5 Analytical tools – 1 2.6 Analytical tools – 2 2.7 Analytical tools – 3 2.8 Tutorial 1 2.9 Supply and demand 2.10 Accountings of naturals assets. 2.11 Tutorial 3	i. What is economics. ii. What are natural assets.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Describe national resource economics.
ii. Discuss about analytical tools.
iii. Describe accountings of naturals assets.

79EV402B.3: Analyze, environmental benefits assets.

`

Approximate Hours

Item	AppX Hrs
Cl	13

LI	0
SW	1
SL	1
Total	15

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Understand pollution economics. **SO3.2 Learn environmental policy analysis.** **SO3.3** Understand command control strategies. **SO3.4** Learn Incentive-based strategies. **SO3.**5 Know economic valuation techniques of environmental benefits assets.		**Unit-3: Pollution economics** 3.1 Environmental policy analysis -1 3.2 Environmental policy analysis -2 3.3 Environmental policy analysis -3 3.4 Tutorial 1 3.5 Command control strategies -1 3.6 Command control strategies -2 3.7 Command control strategies -3 3.8 Tutorial 2 3.9 Incentive-based strategies -1 3.10 Incentive-based strategies- 2 3.11 Economic valuation techniques of environmental benefits assets- 1 3.12 Economic valuation techniques of environmental benefits assets- 2 3.13 Tutorial 3	i. . What is pollution economics?

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Physico-chemical and bacteriological analysis of soil.

ii. Soil micro-organisms and their functions

79EV 402B.4: Explain the techniques of carbon trading and cdm.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	1
SL	1
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Learn carbon tax. **SO4.2** Understand carbon foot print assessment. **SO4.3** Know carbon trading. **SO4.4** Understand clean development mechanism. **SO4.**5 Describe clean production.		**Unit-4: Terminology** 4.1 Carbon tax -1 4.2 Carbon tax -2 4.3 Carbon foot print assessment-1 4.4 Carbon foot print assessment-2 4.5 Tutorial 1 4.6 Carbon trading-1 4.7 Carbon trading-2 4.8 Clean development mechanism - 1 4.9 Clean development mechanism -2 4.10 Tutorial 2 4.11Clean production and technology –1 4.12 Clean production and technology - 2 4.13Eco mark. 4.14Tutorial 3	i. Terminology of environmental economics

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. What is carbon tax?
ii. Describe carbon foot print assessment.
iii. Throw light on clean development mechanism (CDE).

79EV 402B.5: Analysis of environment trade and accounting.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	2
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Understand concept of resource accounting. **SO5.2** Learn Methods and empirical evidences **SO5.3** Know the environment and trade. **SO5.4** Understand Prey-Predator **SO5.**5 Describe supply-demand cycles.		**Unit-5: Natural resources accounting** 5.1 Concepts 5.2 Methods and empirical evidences – 1 5.3 Methods and empirical evidences - 2 5.4 Methods and empirical evidences – 3 5.5 Methods and empirical evidences – 4 5.6 Tutorial 1 5.7 Environment and trade- 1 5.8 Environment and trade- 2 5.9 Tutorial 2 5.10 Prey-Predator and supply-demand cycles-1 5.11 Prey-Predator and supply-demand cycles -2 5.12 Tutorial 3	i. What are natural resources? ii. Prey-Predator.

SW- 5 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the concept of natural resource accounting.
ii. Explain methods and empirical evidences.
iii. What do you mean by supply-demand cycles? Explain.
iv. Describe environment and trade

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
79EV 402B.1: Describe different sources, types, effects & control methods of air pollution.	10	01	01	12
79EV 402B.2: Explain various sources, types, effects and management of pollution.	11	01	02	14
79EV402B.3: Analyze different soil samples.	13	01	01	15
79EV 402B.4**:** Apply noise pollution control technology according to source.	14	01	01	16
79EV 402B.5: Discuss the sources & effects of thermal and nuclear pollution.	12	01	02	15
Total Hours	60	05	07	72

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Fundamental**	03	01	01	05
CO-2	**Tools of Economics**	02	06	02	10
CO-3	**Pollution economics**	03	07	05	15
CO-4	**Terminology**	-	10	05	15
CO-5	**Natural resources accounting**	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Fundamental of Environmental Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Economics of Environment and Development	Kumar Pushpam	Arc Books New Delhi.	2005
2	Environmental and Natural Resource Economics	Tietenberg. T	Pearson Education, New York.	2003
3	Measures of value and Resources- Resources for the future	Freeman A.M	Washington DC	2001
4	Lecture note provided by Dept. of Environmental science, AKS University, Satna.			

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV402B
Course Title: Environmental Economics

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Develop an intuitive capability to understand environmental economics concepts.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2: Implement tool of economic analysis of natural resources.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Analyze, environmental benefits assets.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO4: Explain the techniques of carbon trading and cdm.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO 5: Analysis of environment trade and accounting.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO-1: Develop an intuitive capability to understand environmental economics concepts.	SO1.1SO1.2SO1.3SO1.4 SO1.5		Unit-1 **Fundamental** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10	As mentioned in page number
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 2: Implement tool of economic analysis of natural resources.	SO2.1SO2.2SO2.3 SO2.4 SO2.5		Unit-2 **Tools of Economics** 2.1,2.2,2.3,2.4,2.5,2.6, 2.7, 2.8,2.9,2.10,2.11	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO3: Analyze, environmental benefits assets.	SO3.1SO3.2 SO3.3 SO3.4 SO3.5		Unit-3: **Pollution economics** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12, 3.13	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 4: Explain the techniques of carbon trading and cdm.	SO4.1SO4.2SO4.3SO4.4 SO4.5		Unit-4: **Terminology** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11,4.12,4.13,4.14	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	CO 5: Analysis of environment trade and accounting.	SO5.1SO5.2SO5.3SO5.4 SO5.5		Unit 5: **Natural resources accounting** 5.1,5.2,5.3,5.4,5.5,5.6 ,5.7,5.8,5.9,5.10,5.11,5.12	

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Semester IV

Course Code: 79EV451

Course Title: Major Project/Dissertation Viva

Pre- requisite: Basic Knowledge of handling instruments, sampling, analytical methods and data interpretation.

Rationale: Dissertation work in M.Sc. Environmental Science program is allows students to contribute original research to the field, addressing critical environmental issues and gaps in knowledge. It also enhances their analytical, problem-solving, and research skills, preparing them for professional careers and further academic pursuits.

Course Outcomes:

79EV451.1: Develop and apply advanced research methodologies and techniques to investigate complex environmental issues, enhancing their ability to conduct independent scientific research.

79EV451.2: Analyze and synthesize scientific literature, data, and findings to identify and propose solutions to environmental problems.

79EV451.3: Students will demonstrate the ability to effectively communicate their research findings through well-organized written reports and oral presentations, tailored to both scientific and general audiences.

79EV451.4: Integrate knowledge from various environmental science disciplines (such as ecology, geology, chemistry, and policy) to address their research questions, demonstrating interdisciplinary competence.

79EV451.5: Students will adhere to ethical guidelines and professional standards in the conduct of their research, including data integrity, responsible authorship, and the ethical treatment of research subjects and environments.

Scheme of Studies:

Course Category	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
PCC	79EV451	Major Project/Dissertation Viva	0	0	0	0	0	12

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment

Major Project/Dissertation Viva

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)			
			End Semester Assessment (ESA)			
			Report of Dissertation	Presentation	Viva - Voce	Total Marks
PCC	79EV451	Major Project/Dissertation Viva	40	20	40	100

Guidelines for Project work

To provide expertise in research, project work will be allotted to students of 4th semester. Project topic will be selected by students in 4th semester after review of some research papers according to chosen field in Environmental science.

The Project work can be selected and carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their thesis/ report in the department as per the date announced for the submission.

Assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates.

Dissertation will contain a cover page, certificate signed by student and supervisor,table of contents, introduction, Objective, Literature review, methodology, results and discussions co nclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and half) space.

Curriculum Development Team:

1. Dr. Mahendra Kumar Tiwari, Head of the Department, Dept. of Environmental Science
2. Dr. R. L.S. Sikarwar, Professor, Department, Dept. of Environmental Science
3. Mrs. Suman Patel, Assistant Professor Dept of Environmental Science
4. Mr. Bhupendra Singh, Assistant Professor Dept of Environmental Science
5. Mr. Anurag Chaturvedi, Teaching Associate Dept of Environmental Science

****

A K S University

Faculty of life science and Technology

Department of Environmental Science

Curriculum of M.Sc. (Environmental Science) Program

(Revised as on 01 August 2023)

Cos, POs and PSOs Mapping

Programme Title: M.Sc. Environmental Science
Course Code: 79EV451
Course Title: Major Project/Dissertation Viva

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO 10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
	Environmental Knowledge	Planning abilities	Problem analysis	Design/development of solution for	Modern tool usage	Leadership skills	Professional Identity	Environmental Ethics	Communication	The Environment and society	Environment and sustainability	Life-long learning	Proficiency in Environmental Analysis and Assessment	Application of Multidisciplinary Approaches	Critical Thinking and Problem-Solving Skills	Professional Ethics and Social Responsibility
CO1: Develop and apply advanced research methodologies and techniques to investigate complex environmental issues, enhancing their ability to conduct independent scientific research.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
CO 2: Analyze and synthesize scientific literature, data, and findings to identify and propose solutions to	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**

environmental problems. structure and dynamics.																
CO3: Students will demonstrate the ability to effectively communicate their research findings through well-organized written reports and oral presentations, tailored to both scientific and general audiences.	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO 4: Integrate knowledge from various environmental science disciplines (such as ecology, geology, chemistry, and policy) to address their research questions, demonstrating interdisciplinary competence.	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**
CO5: Students will adhere to ethical guidelines and professional standards in the conduct of their research, including data integrity, responsible authorship, and the ethical treatment of research subjects and environments.	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**3**	**2**	**1**	**3**