

 शिवाजी विद्यापीठ कोल्हापूर जानमेवास्तव Estd. 1962 “A++” Accredited by NAAC (2021) With CGPA 3.52	SHIVAJI UNIVERSITY, KOLHAPUR 416 004, MAHARASHTRA PHONE : EPABX – 2609000, BOS Section – 0231-2609094, 2609487 Web : www.unishivaji.ac.in Email: bos@unishivaji.ac.in शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४, २६०९४८७ वेबसाईट : www.unishivaji.ac.in ईमेल : bos@unishivaji.ac.in		
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SU/BOS/Sci & Tech/366

Date: 08/09/2025

To,

The Principal,
All Concerned Affiliated Colleges/ Institutions,
Shivaji University, Kolhapur.

Subject: Regarding Minor Changes in syllabus of B.Sc. Part –III Pollution as per NEP 2020 degree programme under the Faculty of Science and Technology.

Ref: No. SU/BOS/Science/148 Date: 26/05/2026.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the Minor Changes in syllabi, (Nature of Question paper, equivalence etc.) of B.Sc. Part-III (Sem V & VI) Pollution as per NEP 2020 degree programme under the Faculty of Science and Technology.

This Syllabus, nature of question and equivalence shall be implemented from the academic year **2026-27** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website www.unishivaji.ac.in NEP-2020@suk (Online Syllabus).

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October/ November 2026 & March / April 2027. These chances are available for repeater students, if any

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,



Dy. Registrar

Copy to:

1	I/c Dean, Faculty of Science & Technology	7	Appointment Section A & B
2	Director, Board of Examinations & Evaluation	8	Affiliation Section (T.1) (T.2)
3	The Chairpersan, Respective Board of Studies	9	P.G.Admission Section,
4	B.Sc. Exam Section	10	Computer Centre / IT Cell
5	Eligibility Section	11	Internal Quality Assurance Cell (IQAC)
6	P.G Seminar Section		

SHIVAJI UNIVERSITY, KOLHAPUR.



A++

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Syllabus For

Bachelor of Science III

(POLLUTION)

PAPER IX, X (SEMESTER –V)

PAPER XI, XII (SEMESTER –VI)

(NEP 2020)

Syllabus Implemented From Academic Year 2026- 2027

STRUCTURE OF THE COURSE - B. Sc. III Pollution

SHIVAJI UNIVERSITY, KOLHAPUR								
NEP-2020(2.0): Credit Framework for UG(B.Sc.) Programme under Faculty of Science and Technology								
SEM (Level)	COURSES		OE	VSC/ SEC	AEC/VEC/1 KS	OJT/FP/ CEP /CC/RP	Total Credits	Degree/Cum .Cr. MEME
	Course-1	Course-2						
SEM V(5. 5)	Major IX (2): Reproductive Biology of Angiosperms Environmental Management System Major X(2): Environmental Management System Major P-V(4): (Major) V (On IX and X) PIX (VA) Reproductive Biology of Angiosperms PX (VB) Environmental Management System	Major I (ELEC)(2): Any ONE: i) Environmental Health and Safety ii) Herbarium Techniques Major P-I (ELEC)(2) Any ONE (corresponding to Major I (ELEC)): i) Environmental Health and Safety ii) Practical course in - Herbarium Techniques	OE-5(2) (T/P) Environmental Perspectives in Tourism	VSCII(2) (Major specific) (P): I Soil And Water Sampling	AEC III(2) (English)	OJT (04)	22	UG Degree e132
SEMV I(5. 5)	Major XI (2): Plant Breeding and plant genetic resources management Major XII(2): Environmental Toxicology Major P VI(4): (On XI and XII) PXI (VA) Plant Breeding and plant genetic resources management PXII (VB) Environmental Toxicology	Major II (ELEC)(2): Any ONE: i) Geoinformatics and Environmental Systems ii) plant Metabolism and Stress Physiology Diversity Major P-II(2)(ELEC) Any ONE (corresponding to Major II (ELEC)): i) Geoinformatics and Environmental Systems ii) Plant Metabolism and Stress Physiology		VSCIII(2) (Major specific) (P): II Biofertilizer SECI(2) (T/P): Green Entrepre- neurship and Eco- friendly Products	AECIV(2) (English) IKS2 (Major specific)(2) : Environme- ntal History and Ecology in Modern India	FP- (02)	22	
Credits	8(T)+8(P)=16	4(T)+4(P) =8 -	2(T/P)	2(T/P)+ 4(P)=6	4+2=6	4+ 2= 6	44	

Shivaji University, Kolhapur

Revised Syllabus for Bachelor of Science Part – III: Pollution

1. TITLE: Pollution

2. YEAR OF IMPLEMENTATION: - Revised Syllabus will be implemented from June, 2026 onwards.

Guide lines shall be as per B.Sc.Regular Programme.

Rules and Regulations shall be as per B.Sc.Regular Programme.

Preamble

In alignment with the vision of the National Education Policy (NEP) 2020, the B.Sc. Degree Course in Pollution Studies aims to promote a multidisciplinary, holistic, and application-oriented approach to learning. With growing global and national concern over environmental degradation, pollution control, and sustainable development, this program seeks to equip students with both foundational knowledge and practical skills to understand and address environmental challenges effectively.

The curriculum integrates concepts from physical, chemical, biological, and earth sciences, offering a strong interdisciplinary foundation. In line with NEP 2020's emphasis on experiential learning, the course incorporates laboratory work, field studies, and project-based learning to help students apply theoretical knowledge to real-world environmental problems.

The program encourages critical thinking, innovation, environmental ethics, and research aptitude among students. It also promotes flexibility through multiple entry-exit options and skill-based courses to enhance employability and lifelong learning in the environmental sector.

This syllabus is designed to produce responsible graduates who can contribute meaningfully to national and global efforts in pollution control, environmental management, and sustainable development, thereby supporting India's commitments under the Sustainable Development Goals (SDGs) and the Paris Agreement.

Programme Specific Outcomes (POs)

After completion of the course successfully, students would be able to

1. Apply environment related technical skills for sustainability.
2. Develop the skills to identify Environmental problems.
3. Use the fundamnet also finder disciplinary subjects to solve environmental problems
4. Understand concept and components of environment, history and meaning and Interdisciplinary nature of Environmental Pollution.
5. Identify sources, nature and effects of pollutants on global and local environment.
6. Perform procedure for qualitative and quantitative analysis of pollutants.
7. Assess the effects of pollutants and suggest the control
8. Apply the environmental conservation strategies
9. Create the interest of the society in the conservation of natural resources and improve the environmental quality through exhibitions and other similar activities.

6. **DURATION** - The course shall be a full time course.

7. **PATTERN** - Pattern of Examination will be Semester type for theory as well as practical.

8. SCHEME OF EXAMINATION:- (THEORY/PRACTICAL/INTERNAL):

Total marks shall be 50 for 2 credit courses.

The university exam question paper in each semester end examination for each theory course (paper) for B.Sc. (all Semesters) shall be of 40 marks. Total marks for each course shall be based on continuous assessments and semester-end examination. The division of internal assessment and semester-end examination for B.Sc. will be as follows:

Particulars	2 Credit	Course Duration
1.Semester-end Examination	40Marks	1.5hrs.
2.Internal Assessment	10Marks	1.0hrs.
Total marks for each course	50Marks	—

1. The Examination for practical course will be of 50 marks at end of each semester. The rule for practical examination shall be as per the circular/ letter issued by respective board of studies.
2. The examination pattern for Co-Curricular Activities (CC), Field Project (FP), On Job Training (OJT), Community Engagement Program (CEP) and Research Project (RP) as per the University guidelines.

Internal Assessment Process shall be as follows:

- (a) The internal assessment should be conducted after completing 50% of syllabus of the course/s.
- (b) In case a student has failed to attend internal assessment on scheduled date, it shall be deemed that the student has dropped the test. However, in case of student who could not take the test on scheduled date due to genuine reasons, such a candidate may appeal to the Programme coordinator/Principal/Head of the Department. The programme coordinator/Principal/Head of the Department in consultation with the concerned teacher shall decide about the genuineness of the case and decide to conduct special test to such candidate on the date fixed by the concerned teacher but before commencement of the concerned semester- end examination.

The outline for continuous internal assessment activities shall be as under: Outline of continuous internal assessment activities

Level	Semester	Activities Per Semester	Marks
4.5	Semester-I	Assignment	10marks
	Semester-II	Unit test	10marks
5.0	Semester-III	Unit test	10marks
	Semester-IV	Oral examination/ Group discussion	10marks
5.5	Semester-V	Seminar/Group discussion/Field Work	10marks
	Semester-VI	Study tour/ Field Work/Project Work	10marks
6.0	Semester-VII	Case Study/Field Work/ Project Work	10marks
	Semester-VIII	Case Study/FieldWork/ Project Work	10marks

SEMESTERV								
TEACHING SCHEME								
		THEORY			PRACTICAL			
Sr.No.	Subject Title	Credits	No. of periods	Hours	Credits	No .of periods	Hours	Total
SEMESTERV								
1	(Major)Paper-IX	2	2	2	2	4	4	6
2	(Major)Paper-X	2	2	2	2	4	4	6
3	Major(Elective) Paper -I	2	2	2	2	4	4	6
4	VSCII(P)(Major specific)	2			2	4	4	4
5	OE(T/P)	2	2(T),4(P)	2	2	4	4	4
6	OJT				4	8	8	8
Total		8	8+2	8	14	28	28	34+/- 2
SEMESTERVI								
7	(Major)Paper-XI	2	2	2	2	4	4	6
8	(Major)Paper-XII	2	2	2	2	4	4	6
9	Major(Elective) Paper -II	2	2	2	2	4	4	6
10	VSCIII(P)(Majorspecific)				2	4	4	4
11	SEC III(T/P)	2	2(T),4(P)	2	2	4	4	4
12	IKS II(Majorspecific)	2	2					2
13	FP				2	4	4	4
	TOTAL	10	10+2	8	12	24	24	34+/-2
GRANTTOTAL		18	18+2+2	16	26	52	52	64+/-4

STRUCTURE OF COURSE
B.Sc.III Pollution (Optional)
THIRD YEAR (SEMESTER V/VI)(NO.OF PAPERS,PRACTICALS OJT&FP)

Sr.No.	Subjects/Papers	Theory	Internal	Practical	Total Marks
SEMESTER V					
1	(Major) Paper-IX	40	10	50	100
2	(Major) Paper-X	40	10	50	100
3	Major(Elective) Paper-I	40	10	50	100
4	VSCII(P)(Major specific)				50
5	OE(T/P)	40	10	50	50
6	OJT				100
SEMESTER VI					
7	(Major)Paper-XI	40	10	50	100
8	(Major)Paper-XII	40	10	50	100
9	Major(Elective)Paper-II	40	10	50	100
10	VSCIII(P)(Major specific)	-		50	50
11	SEC III(T/P)	40	10	50	50
12	IKSII(Major specific)	40	10	-	50
12	FP				50
	Total				1000

1. EQUIVANLENCE IN ACCORDANCE WITH TITLES AND CONTENTS OF PAPERS

Due to NEP 2.00 makes it impossible to provide
equivalence (FOR REVISED SYLLABUS)

(Introduced from June 2026 onwards)

Revised Syllabus (Semester pattern)		
Sem. No.	PaperNo.	Title of New Paper
V	Major IX	Reproductive Biology of Angiosperms
	Major X	Environmental Management System
	Major specific Elective I	Environmental Health and Safety
	Major Elective I	Fungal Diversity And Its Industrial Applications
	Major Elective I	Herbarium Techniques
	Major Elective I	Industrial Botany And Applied Plant Sciences
	VSC II (Major specific)	Soil and Water Sampling
	OE II	Environmental Perspectives in Tourism
	OJT	On Job Training
VI	Major XI	Plant Breeding and plant genetic resources management
	Major XII	Environmental Toxicology
	Major specific Elective II	Geoinformatics and Environmental Systems
	Major Elective II	Plant Metabolism and Stress Physiology
	Major Elective II	Epidemiology and Control of Emerging Crop Diseases
	Major Elective II	Measures And Sustainable uses of Plant Diversity
	Major Elective II	Industrial Phytotechnology And Agro-Botany
	VSC III (Major specific)	Biofertilizer (Pollution Control)
	SEC III	Green Entrepreneurship and Eco-friendly Products
	IKSII(Major specific)	Environmental History and Ecology in Modern India
	FP	Field Project

SHIVAJI UNIVERSITY, KOLHAPUR									
NEP-2020(2.0):Credit Framework for UG(B.Sc.) Programme under Faculty of Science and Technology									
SEM (Level)	COURSES			OE	VSC/SEC	AEC/VEC/IKS	OJT/FP/CEP/CC/RP	TOTAL CREDITS	Degree/Cum.Cr.ME
	Course-1	Course-2	Course-3						
SEMI (4.5)	DSC-I(2) DSC-II(2) DSCP-I(2)	DSC-I(2) DSC-II(2) DSCP-I(2)	DSC-I(2) DSC-II(2) DSCP-I(2)	OE-1(2)(T/P)		IKS-I(2)		22	UGC Certificate 44
SEM II (4.5)	DSC-III(2) DSC-IV(2) DSCP-I(2)	DSC-III(2) DSC-IV(2) DSCP-I(2)	DSC-III(2) DSC-IV(2) DSCP-I(2)	OE-2(2)(T/P)		VEC-II(2) (Democracy, Election and Constitution)		22	
Credits	8(T)+4(P)=12	8(T)+4(P)=12	8(T)+4(P)=12	2+2=4 (T/P)		2+2=4		44	Exit Option: 4 credits NSQF/Internship/Skill courses
	Major		Minor						
SEM III (5.0)	Major V(2) Major VI(2) Major PIII(2)		Minor V(2) Minor VI(2) Minor PIII(2)	OE-3(2)(T/P)	VSCI(2)(P) (Majorspecific) SECI(2)(T/P)	AECI(2) (English)	CC-I(2)	22	UG Diploma 8
SEM IV (5.0)	Major VII(2) Major VIII (2) Major PIV(2)		Minor VII(2) Minor VIII(2) Minor PIV(2)	OE-4(2)(T/P)	SECI(2)(T/P)	AECII(2) (English) VEC-II(2) (Environmental studies)	CEP-I(2)	22	
Credits	8(T)+4(P)=12		8(T)+4(P)=12	2+2=4 (T/P)				44	Exit Option: 4 credits NSQF/Internship/Skill courses
SEM V (5.5)	Major IX(2) Major X(2) Major PVA(2) Major PV B(2)	Major I(ELEC)(2) Major P-I(ELEC)(2)		OE-5(2)(T/P)	VSCI(2)(P) (Majorspecific)	AECIII(2) (English)	OJT(4)	22	UG Degree 132
SEM VI (5.5)	Major XI(2) Major XII (2) Major PVIA(2) Major PVI B(2)	Major II(ELEC)(2) Major P-II(ELEC)(2)			VSCII(2)(P) (Majorspecific) SECI(2)(T/P)	AECIV(2) (English) IKS-II(2) (Majorspecific)	FP(2)	22	
Credits	8(T)+8(P)=16	4(T)+4(P)=8		2(T/P)	2(T/P)+4(P)=6	4+2=6	4+2=6	44	
Total Credits	40+20=60		24	10	12	16	10	132	Exit option
SEM VII (6.0)	Major-XIII(4) Major-XIV(4) Major(P)-VII(4) Major(P)-VIII(2)	Major III (4) (ELEC)	RM-I(4)					22	UG Honours Degree 176
SEM VIII (6.0)	Major -XV(4) Major -XVI(4) Major(P)-IX(4) Major(P)-X(2)	Major IV (4)(ELEC)					OJT(4)	22	
Credits	16(T)+12(P)=28	8(T)	4					44	
Total Credits	68+28=96		28	10	12	16		176	Exit option
SEM VII (6.0)	Major-XIII(4) Major-XIV(4) Major(P)-VII(2)	Major(4)(ELEC)	RM-I(4)				RP-(4)	22	UG Honours with research Degree 176
SEM VIII (6.0)	Major-XV(4) Major-XVI(4) Major(P)-VIII(2)	Major(4)(ELEC)					RP-(8)	22	
Credits	16(T)+4(P)=20	8(T)	4				12	44	
Total Credits	60+28+88		28	10	12	16	22	176	

EQUIVALANCE OF THE PAPER

Equivalence of papers and chances for the students in previous-Semester pattern: Two additional chances in subsequent semesters shall be provided for the repeater students of old three-year B.Sc.program. In such case the scores obtained by the students in NEP1.0/CBCS schemes should be converted in to equivalent credits in NEP 2.0. After that the students concerned shall have to appear for the examination as per this revised pattern. If a student fails in two consecutive chances, he/she must take admission for the respective course in NEP 2.0. In such cases his/her previous performance of incomplete academic years (B.Sc.I, B.Sc.II, and or B.Sc.III) will be cancelled.

SCHEME OF TEACHING:

TEACHING HOURS: All courses under the B. Sc. II will be of 2 credits each. The theory courses will be taught for 30 hours and Practical courses for 60 hours. All the major and minor subjects will have Practical Courses. In addition, VSC, OE and SEC have practical modules.

9 DETERMINATION OF SGPA/CGPA:

1. Semester Grade Point Average (SGPA)

$\Sigma(\text{Course credits} \times \text{Grade points obtained})$ of a semester

SGPA = _____

$\Sigma(\text{Course credits})$ of respective semester

2. Cumulative Grade Point Average (CGPA)

$\Sigma(\text{Total credits of a semester} \times \text{SGPA of respective semester})$ of all semester

CGPA = _____

$\Sigma(\text{Total course credits})$ of all semesters

Gradation Chart:

% of Marks Obtained	Numerical Grade (Grade Point)	CGPA	Letter Grade
Absent	-	-	-
0-34	0	0.0-4.99	F (Fail)
35-44	5	5.00-5.49	C
45-54	6	5.50-6.49	B
55-64	7	6.50-7.49	B+
65-74	8	7.50-8.49	A
75-84	9	8.50-9.49	A+
85-100	10	9.50-10.0	O (Outstanding)

10.Nature of Question Paper for B.Sc. Part – I, II & III (40 + 10 Pattern) according to Revised Structure as Per NEP - 2020 to be implemented from academic year 2026-27

Maximum Marks: 40

Duration: 1:30 hrs

Q. 1 Select the most correct alternative from the following

[8]

i) to viii) MCQ one mark each with four options

A)

B)

C)

D)

Q.2 Attempt any TWO of the following

[16]

A)

B)

C)

Q. 3 Attempt any FOUR of the following

[16]

A)

B)

C)

D)

E)

F)

SEMESTER–V

BOTANY Paper IX (Major):

DSC: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

Course Objectives

- To introduce students to the fundamental concepts of reproductive biology of angiosperms.
- To understand structure, development, and functioning of reproductive organs.
- To correlate theoretical knowledge with laboratory-based practical observations.

Course Outcomes:

- After completion of the course, students able to.
- Explain the reproductive structures and processes in angiosperms
- Describe anther, pollen, and ovule, pollination, and fertilization mechanisms.
- Apply basic reproductive biology concepts through practical demonstration

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Organization of a flower Pollinationand Fertilization	Concept of flower as a modified shoot (Stem nature of thalamus and leaf nature of floral parts).Structure and functions of a typical stamen; structure of a tetrasporangiate anther and pollen grain. Structure and functions of a typicalcarpel. Structure of a typical ovule and its types.	08
	Embryo and Endosperm Development	Pollination: Definitionand Types(Anemo-Zeamays;Hydrophily-Vallisneriaspiralis;EntemophilyCalotroisgigantea) .Microsporogenesis; pollen germinat on and development of male gametophyte. Megasporogenesis; development to fembryosac: Monosporic, Bisporic and Tetrasporic. Fertilization: Definition and Importance.Entryofpollen tube (Porogamy, Chalazogamy and Mesogamy). Double Fertilization and triple fusion and its significance.	07 07
2		Development of and types of endosperms (Nuclear,Helobial and Cellular). Development and structure of dicotandmonocotembryo in angiosperms. Polyembryony: Introduction and causes of polyembryony. Types of polyembryony (Truepolyembryony-Clevage and Adventative; False polyembryony.) Significance of polyembryony. Apomixis: Introduction and Types (Gametophytic and sporophytic). Significance of apomixis	08 07
Total Lectures			30

SEMESTER–V
POLLUTION Paper X (Major):
DSC: Environmental Management System

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Basics of Environmental Management		
	1.1 Introduction to EMS	Definition and concept of Environmental Management Importance and need of environmental management Introduction to Environmental Management System (EMS) Overview of ISO 14001; Role of environmental policies and regulations	08
	1.2 Environmental Planning and Impact Assessment	Environmental Planning Process Environmental Impact Assessment (EIA) – Steps Risk Assessment Waste Management Principles (3R – Reduce, Reuse, Recycle)	08
2	Environmental Monitoring and Applications		
	2.1 Environmental Monitoring and Auditing	Environmental Monitoring (Air, Water, Soil) Environmental Audit – Types & Importance Environmental Performance Indicators Carbon Footprint & Energy Audit (Basic Concept)	06
	2.2 Environmental Management Tools and Applications	Green Corporate Social Responsibility (CSR) & Environment ; Role of industries in environmental protection; Sustainable environmental practices	08
Total Lectures			30

Learning Outcomes

1. Understand the basic concepts, classification and sources of environmental toxicants..
2. Identify major environmental toxicants and their sources in air, soil and water.
3. Explain and understand **the** impact of environmental toxicants on ecosystems, plants, animals and human health.
4. Develop knowledge about toxicity monitoring, risk assessment and management of toxic pollutants..
5. Develop skills for detection, monitoring and management of toxic pollutants.

LABORATORY COURSE PRACTICAL –V(A) (Major)

Based on Paper IX (Total Marks-50)

Paper IX: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Course Objectives

- To identify the structural organization of atypical angiosperm flower.
- To understand the function of epidermis, endothelium, middle layers, and tapetum
- To analyze structural variations in pollenexine and aperture patterns.
- To determine optimal sucrose concentration required for pollen tube growth.
- To isolate intact embryos from young developing dicot seeds.

Course Outcomes

- Students can classify floral organs based on reproductive functionality
- Students identify the four distinct layers of the anther wall
- Students utilize palynological terminology to describe diverse pollen shapes
- Students prepare viable nutritive mediums for in-vitro pollen germination
- Students successfully extract intact dicotembryos without inflicting tissue damage.

PRACTICAL SYLLABUS (15Practical's)

1. Study of flower as a reproductive unit:
Thalamus, Accessory and Necessary whorls(Any suitable material).
2. Study of T.S.of tetra sporangia anther(Any suitable material).
3. Study of pollen morphology and pollen viability with any suitable method.
4. Study of pollen germination by hanging drop method.
5. Study of ovule types through permanent slides/Charts/Photos.
6. Study of embryo sac types through permanent slides/Charts/Photos.
7. Dissection of dicotembryo from any suitable material.
8. Study of structure of floral parts (pollinate) and pollination mechanism in *Calotropis*.
9. Study of structure of dicot embryo with the help of Photograph/Model/Staining method.
10. Study of structure of monocot embryo with the help of Photograph / Model / Staining method.
11. Study of diversity in the structure of stigma and stigmatic papillae.
12. Study of anatomical diversity in the morphology of style.
13. Study of structure of endo sperm with the help of Photograph/Model/Staining method.
14. Study of structure of floral parts and pollination mechanism in Maize.
15. Botanical Excursion to familiarize students with different plants.(Report should be written in Journal).

LABORATORY COURSE PRACTICAL –V (B) (Major)

Based on Paper X (Total Marks-50)

Paper X: Environmental Management System

1. Study of environmental management concepts through charts and models.
2. Preparation of EIA flowchart showing different stages.
3. Survey of solid waste generation in college campus.
4. Classification of waste into biodegradable and non-biodegradable.
5. Demonstration of 3R concept (Reduce, Reuse, Recycle) using college waste.
6. Preparation of environmental monitoring data sheet.
7. Simple carbon footprint calculation of household activities.
8. Preparation of energy audit checklist for college building.
9. Preparation of report on cleaner production practices.
10. Preparation of Environmental Performance Indicators (EPIs) for a College Campus
11. To calculate the Water Quality Index of given water sample using selected water-quality parameters.
12. Field survey of local environmental problems.

Semester -VI
BOTANY Paper XI (Major):

DSC: PLANT BREEDING AND PLANT GENETIC RESOURCES MANAGEMENT
CREDIT: 2. LECTURE PERIODS: 2 PER WEEK MARKS: 50

MODULE	SUB-MODULE	TOPICS	LECTURE PERIODS
1. Plant Breeding	1.1 Introduction to plant breeding and Selection Methods	Definition, aim, objectives, and scope of plant breeding Domestication, plant introduction, Quarantine; and Acclimatization of plants, Germplasm, plant introduction agencies in India–National Bureau of Plant Genetic Resources (NBPGR) and merits and demerits of plant introduction. Selection methods-i) Mass selection, ii) Pureline selection, iii) Clonal selection, procedure for evolving a variety by these selection methods, merits, demerits and achievements.	08
	1.2 Hybridization techniques in Plant breeding	Hybridization techniques: i) aims and objectives, ii) types of hybridization: in self-pollinated and cross-pollinated crops, iii) procedure / steps involved in hybridization, heterosis and hybrid vigour. Male sterility – different types – genetic, cytoplasmic, and cytoplasmic genetic male sterility, application in crop improvement. Mutation breeding, spontaneous and induced mutations, procedure of mutation breeding, applications, advantages, limitations, and achievements Experimental designs and biometrical techniques in plant breeding- Randomized block design, Analysis of variance, Assessment of variability, Hardy Weinberg Law of equilibrium	08
Unit-2: Plant Genetic Resource Management	2.1 Plant Genetic Resources (PGR)	Introduction: Definition, scope, and objectives of PGR. Centres of Diversity: Vavilov's centres of origin and diversity, agro-biodiversity hotspots, Gene Pool Germplasm Collection and Exploration: Exploration Strategy: Strategies for exploration and collection of cultivated and wild relatives. Sampling Techniques: Methods for collecting germplasm (random vs. targeted). Evaluation: Screening for biotic (pests, diseases) and abiotic stresses (drought, salinity).	06
	2.2 Conservation Strategies (PRG) Management	Ex situ Conservation: Seed banks (short/medium/long-term), field gene banks, in vitro conservation, and cryopreservation. In situ Conservation: On-farm conservation, biosphere reserves, protected areas. Importance of genetic conservation, Global network for genetic conservation and utilization in major crops of world, Institutes engaged in conservation and improvement of crop genetic resources, Wild relatives of crop plants, Gene banks, Gene sanctuaries	08
Total Lectures			30

Semester -VI
POLLUTION Paper XII (Major):
DSC: Environmental Toxicology

CREDIT: 2. LECTURE PERIODS: 2PER WEEK

MARKS: 50

MODULE	SUB-MODULE	TOPICS	LECTURE PERIODS
1	Introduction to Environmental Toxicology		
	1.1 Introduction to Environmental Toxicology	Definition, concept and scope of Environmental Toxicology. Types of toxic substances in environment, Sources of environmental pollutants (natural and anthropogenic), Classification of toxicants (chemical, biological and physical) Basic principles of toxicity: dose, exposure and response Acute and chronic toxicity	06
	1.2 Toxic Substances and Their Environmental Sources	Heavy metals (lead, mercury, cadmium, arsenic) Agricultural chemicals (pesticides, herbicides, fertilizers) Industrial pollutants and toxic wastes; Air pollutants with toxic effects; Toxic contaminants in soil and water	08
2	Toxicity Assessment and Environmental Management		
	2.1 Effects of Toxicants on Living Organisms	Entry of toxic substances into living organisms Toxic effects on plants Toxic effects on animals and human health Bioaccumulation and biomagnifications Toxicity in aquatic ecosystems; Ecological impacts of environmental toxins	08
	2.2 Toxicity Assessment and Environmental Management	Methods for toxicity testing; Biomonitoring and Bioindicators; Environmental risk assessment; Toxic waste management and treatment; Pollution control strategies; Environmental laws related to toxic substances	08
Total Lectures			30

Course Outcome (Cos):-

1. Understand the basic concepts, classification and sources of environmental toxicants..
2. Identify major environmental toxicants and their sources in air, soil and water.
3. Explain and understand **the** impact of environmental toxicants on ecosystems, plants, animals and human health.
4. Develop knowledge about toxicity monitoring, risk assessment and management of toxic pollutants..
5. Develop skills for detection, monitoring and management of toxic pollutants.

Semester -VI

LABORATORY COURSE PRACTICAL –VI (A) (Major)

Based on Paper XI

PRACTICALS BASED ON MAJOR XI, VA PLANT BREEDING AND PLANT GENETIC RESOURCES MANAGEMENT

Credits:2; 4Hours per week Total:60Hours: 50Marks

Practicals:

1. Study of methods of emasculation.
2. Breeding techniques in the crops of Malvaceae, Fabaceae and Poaceae.
3. To study the floral biology of self-pollinated and cross-pollinated species
4. Study of pollen germination and demonstration of incompatibility.
5. To study cross ability between cultivars.
6. Study of cytoplasm male sterility in maize crop.
7. To study the effect of mutagens on germination, seedling growth.
8. Demonstration of different seed banks such as orchards.
9. Study of in-vitro conservation methods for vegetative propagated crop plants.
10. Calculating mean, range, variance, and standard deviation to evaluate genetic variability with in crops.
11. Study of Vavilov's centres of origin of crop plants.
- 12.13 Study of abiotic stress tolerance assessment in crop plants (drought/salinity/temperature)
- 14.15 Preparation of Project report on (any one of the following):—a) Seed bank
b) Collection of wild germplasm.

References

- Allard, R.W. 1960. *Principles of Plant Breeding*. John Wiley and Sons, New York.
- Phundan Singh, 2006. *Essentials of Plant Breeding*. Kalyani Publishers, New Delhi.
- Poehlman, J.M. and Borthakur, D. 1995. *Breeding Asian Field Crops*. Oxford and IBH Publishing Co., New Delhi.
- Sharma, J.R. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw Hill, Publishing Company Ltd., New Delhi.
- Singh, B.D. 2006. *Plant Breeding: Principles and Methods*. Kalyani Publishers, New Delhi.

Semester -VI

LABORATORY COURSE PRACTICAL –VI (B) (Major)

Environmental Toxicology

Based on Paper XII

(Total Marks-50)

1. Study of laboratory safety rules in toxicology.
2. Identification of common environmental toxicants from charts/specimens.
3. Determination of Biological Oxygen Demand (BOD).
4. Determination of Chemical Oxygen Demand (COD) from Waste Water.
5. Detection of heavy metals in water samples (demonstration).
6. Determination of phosphate in water.
7. Observation of pesticide effects on seed germination.
8. Study of pollution indicator plants.
9. Observation of effects of pollutants on plant leaves.
10. Demonstration of biomagnifications using ecological diagrams.
11. Survey of plastic waste in local environment.
12. Determination of oil and grease from given water sample
13. To study the effect of different concentrations of detergent-contaminated water on seed germination and seedling growth.
14. To study and compare the visible morphological symptoms of air pollution in selected plants growing at different locations.

Semester -V

POLLUTION MAJOR PAPERS (Elective) DSC: Environmental Health and safety

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

MODULE	SUB-MODULE	TOPICS	LECTURE PERIODS
1	Occupation, Monitoring for Safety, Health & Environment		
	1.1 Occupation, Safety And Management	Occupational Safety, Health and Environmental Safety, – Principles & practices, Role of Management in Industrial Safety, Planning for Safety: Planning: Definition, purpose, nature, scope and procedure. Management by objectives and its role in Safety	08
	1.2 Monitoring for Safety, Health & Environment	Environment Management System, Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000. Principles of Accident Prevention: Definition: Incident, accident, injury, dangerous, occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes etc.	08
2	Personal Protective Equipment and Employee Participation in Safety		
	2.1 Personal Protective Equipment	Need for Personal Protection Equipment, Selection, Use, Care & Maintenance Respiratory and Non-respiratory Personal Protective Equipment, Head Protection, Ear Protection, Face and Eye Protection, Hand Protection, Foot Protection, Body Protection. Standards & regulations	06
	2.2 Education, Training and Employee Participation in Safety:	Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Competence Building Techniques (CBT), Concept for training, safety as a on-line function. Employee Participation: Purpose, areas of participation, methods, Role of trade union in Safety, Health and Environment Protection	08
Total Lectures			30

Learning Outcomes

- 1: Understand the basic concepts of occupational safety, health and environmental management.
- 2: Identify hazards, unsafe acts and unsafe conditions in workplace environments.
- 3: Demonstrate knowledge of personal protective equipment (PPE) and their proper use and maintenance.
- 4: Understand safety planning, accident prevention and environmental monitoring systems.
- 5: Develop awareness about safety training, competence building techniques and employee participation in safety programs.

Semester -V
LABORATORY COURSE PRACTICAL
MAJOR PAPERS (Elective)
Environmental Health and safety
(Total Marks-50)

1. Study of occupational hazards in laboratory / workshop environment.
2. Identification of unsafe acts and unsafe conditions in a workplace.
3. Preparation of workplace safety checklist for laboratory safety.
4. Study of incident and accident reporting formats used in industries.
5. Case study analysis of a major industrial accident and preventive measures
6. Preparation of a basic safety plan for a small laboratory or industry.
7. Preparation of risk assessment chart for common workplace hazards.
8. Study of Environmental Management System (EMS) components.
9. Familiarization with Bureau of Indian Standards (BIS) guidelines related to safety.
10. Preparation of environmental monitoring checklist for workplace safety.
11. Demonstration of basic safety audit procedure.
12. Identification and demonstration of different types of Personal Protective Equipment (PPE).
13. Study of respiratory protective equipment and their uses.
14. Study of non-respiratory PPE such as helmets, gloves, goggles and safety shoes.
15. Preparation of a safety training module for employees or students.
16. Demonstration of different training methods in safety education (lecture, demonstration, simulation).

REFERENCE BOOK LIST

1. R.K. Jain and Sunil S. Rao – *Industrial Safety, Health and Environment Management Systems*, Khanna Publishers, New Delhi.
2. L.M. Deshmukh – *Industrial Safety Management: Hazard Identification and Risk Control*, Tata McGraw- Hill Publishing Company, New Delhi.
3. John Ridley and John Channing – *Safety at Work*, Butterworth–Heinemann / Routledge Publications.
4. H.W. Heinrich, D. Petersen and N. Roos – *Industrial Accident Prevention: A Scientific Approach*, McGraw- Hill Book Company.
5. Slote L. – *Handbook of Occupational Safety and Health*, John Wiley & Sons.
6. Goetsch D.L. – *Occupational Safety and Health for Technologists, Engineers and Managers*, Pearson Education.
7. Bureau of Indian Standards (BIS) –
IS 14489: Code of Practice on Occupational Safety and Health Audit.
8. Bureau of Indian Standards (BIS) –
IS 15001: Occupational Health and Safety Management Systems – Requirements.
9. United Nations General Assembly (1987) Report of the World Commission on Environment and Development: Our Common Future.

BOTANY-POLLUTION
Semester -V
MAJOR PAPERS (Elective)
HERBARIUM TECHNIQUES

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Fundamentals Of Herbarium Techniques		
	1.1 – Introduction and Collection Techniques	Introduction to Herbarium: Definition, history, objectives and importance Types of herbaria: National, regional, institutional and virtual herbaria Major herbaria of India and the world Role of herbaria in taxonomy, biodiversity, ecology and conservation Herbarium equipment and materials Methods of plant collection and field techniques Ethical considerations and legal aspects of plant collection Field notes and documentation, techniques	07
	1.2 Herbarium Preparation and Maintenance	Plant press in methods and drying techniques Poisoning and preservation methods Mounting techniques for herbarium specimens Herbarium label preparation and accessioning Preservation of special plant groups Common problems in herbarium Care, storage and	08
2	Advanced Herbarium Techniques And Applications		
	2.1 Identification and Digitization Techniques	Identification of plants using floras, manuals and taxonomic keys Nomenclature and herbarium citation methods Preparation and maintenance of digital herbaria Herbarium data bases and cataloguing systems Imaging and scanning techniques for herbarium specimens Herbarium standards and international	07
	2.2 Applications and Modern Trends in Herbarium Science	Conservation and restoration fold herbarium specimens Role of herbarium in environmental impact assessment Herbarium applications in pharmacognosy and ethnobotany Herbarium applications in climate change and biodiversity studies Molecular approaches and DNA sampling from herbarium	08
	Total Lectures		30

COURSE OUTCOMES (COs)

After completion, students will be able to:

- Understand the role and significance of herbarium botanical sciences.
- Collect, process, preserve, and mount plant specimens scientifically.
- Prepare herbarium labels and maintain herbarium records.
- Identify plant specimens using floras, manuals, and keys.
- Understand herbarium management and digitization techniques

BOTANY-POLLUTION
Semester -V
LABORATORY COURSE PRACTICAL
MAJOR PAPERS (Elective)
HERBARIUM TECHNIQUES

(Total Marks-50)

Practicals

- 1) Study of herbarium tools, equipment and field kit
- 2) Field visit for plant collection and field note preparation
- 3) Methods of plant pressing and drying
- 4) Preparation of blotters and plant presses
- 5) Mounting of herbarium specimens
- 6) Preparation of herbarium labels
- 7) Preservation techniques for delicate specimens
- 8) Preparation of herbarium sheets for grasses and aquatic plants
- 9) Identification of plant specimens using floras and keys
- 10) Study of major herbaria(virtual/physical visit)
- 11) Herbarium accessioning and cataloguing
- 12) Digitization and photography of herbarium specimens
- 13) Management and storage of herbarium specimens
- 14) Preparation of thematic herbarium collections
- 15) Submission of mini-herbarium collection with field report

Suggested References

1. Jain, S.K. & Rao, R.R. – A Hand book of Field and Herbarium Methods.
2. Bridson, D. & Forman, L. – The Herbarium Handbook.
3. Lawrence, G.H.M. – Taxonomy of Vascular Plants.
4. Singh, G. – Plant Systematics : Theory and Practice.
5. Simpson, M.G. – Plant Systematics.
6. Woodland, D.W. – Contemporary Plant Systematics.
7. Radford, A.E. – Fundamentals of Plant Systematics.
8. Hyland, B.P.M. – Herbarium Handbook for Plant Identification.
9. Fosberg, F.R. & Sachet, M.H. – Manual for Tropical Herbarium Techniques.
10. Victor, J.E., Smith, G.F. & Van Wyk, A.E. – Herbarium Essentials.
11. Harris, J.G. & Harris, M.W. – Plant Identification Terminology: An Illustrated Glossary.
12. Stace, C.A. – Plant Taxonomy and Biosystematics.
13. International Association for Plant Taxonomy (IAPT) – International Code of Nomenclature.
14. Forman, L. & Bridson, D. – The Herbarium Handbook (Revised Edition).
15. Pandey, B.P. – Taxonomy of Angiosperms.
16. Sharma, O.P. – Plant Taxonomy.

POLLUTION
Semester -VI
MAJOR PAPERS (Elective)
Geoinformatics and Environmental Systems

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Fundamentals of Environmental Systems and Natural Hazards		
	1.1 Fundamentals of Environmental Systems	Meaning and scope of Environmental Systems, Structure of the Earth – Crust, Mantle, Core, Rocks and Minerals – types and importance, Weathering and Soil Formation, Human impact on environment (mining, urbanization)	06
	1.2 Natural Hazards And impact on	Natural Hazards – Earthquake, Flood, Landslide, Human impact on environment (mining, urbanization)	08
2	Basics of Geoinformatics and Applications of Geoinformatics		
	2.1 Basics of Geoinformatics	Introduction to Geoinformatics, Components of GIS, Spatial and non-spatial data, Raster and vector data models, GPS – principles and uses, Introduction to Remote Sensing	06
	2.2 Applications of Geoinformatics	GIS in urban planning, GIS in agriculture and forestry, Basics of digital mapping, Concept of overlay analysis	10
			30

COURSE OUTCOMES (COs)

After completion, students will be able to:

- 1** – Explain forest ecosystem structure and environmental factors.
- 2** – Describe physiological processes in forest trees.
- 3** – Analyze effects of pollution stress on forest vegetation.
- 4** – Perform simple ecophysiological experiments and field studies.
- 5** – Suggest conservation and Afforestation strategies

Reference Books

1. Albretcht, J. (2007): Key Concepts & Techniques in GIS, SAGE Publications Ltd., London
2. Burroughs, P.A. and McDonnell, R.A. (1998): Principles of Geographic Information Systems, Oxford University Press, New York
3. Clark, K.C. (2010): Getting Started with Geographic Information Systems, Prentice Hall, Upper Saddle River, New Jersey
4. Daniel, J., Loree, P. and Whitener, A. (2002): Inside Mapinfo Professional, Onword Press, Albany, New York
- Fazal, S. (2008): GIS Basics, New Age International (P) Limited, Publishers, New Delhi
4. Harvey, F. (2008): A Primer of GIS: Fundamental Geographic and Cartographic Concepts, The Guilford Press, New York
5. Heywood, D.I., Cornelius, S. and Carver, S. (2006): An Introduction to Geographical Information Systems, Prentice Hall, Upper Saddle River, New Jersey
6. Longley, P., Goodchild, M., Maguire, D.J. and Rhind, D.W. (2011): Geographic Information Systems and Science, John Wiley & Sons, New York
7. Shekhar, S. and Xiong, H. (eds.) (2008): Encyclopaedia of GIS, Springer, New York

POLLUTION
Semester -VI
MAJOR PAPERS (Elective)
LABORATORY COURSE PRACTICAL
Geoinformatics and Environmental Systems

1. Identification of common rocks
2. Study of soil profile
3. Preparation of simple hazard map (India outline)
4. Study of topographic map
5. Map reading – scale, contour, symbols
6. Collection of GPS coordinates (mobile GPS method)
7. Preparation of simple thematic map (manual method)
8. Study of map components (title, scale, legend, north arrow)
9. Manual digitization using tracing sheet
10. Preparation of land use map (colour method)
11. Study of topographic map
12. Collection of GPS coordinates (mobile-based)
13. Preparation of contour sketch
14. Preparation of thematic map (population/land use)

BOTANY-POLLUTION**Semester -VI****MAJOR PAPERS (Elective)****PLANT METABOLISM AND STRESS PHYSIOLOGY**

CREDIT: 2. LECTURE PERIODS: 2 PER WEEK

MARKS: 50

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Plant Metabolism		
	1.1 Nitrogen Metabolism	Introduction to metabolism , anabolism and catabolism Nitrogen Metabolism Introduction and Importance of Nitrogen: Role of nitrogen in plant metabolism Sources and Forms of Nitrogen : Atmospheric nitrogen, Soil nitrogen forms: nitrate (NO_3^-) and ammonium (NH_4^+) Nitrogen Uptake by Plants : Uptake of nitrate and ammonium Biological Nitrogen Fixation: Concept and significance of nitrogen fixation, Conversion of atmospheric nitrogen into usable form, Nitrogen Types of Nitrogen Fixation : Symbiotic nitrogen fixation, non-symbiotic nitrogen fixation Nitrogenase Enzyme: Structure and function Nitrate Reduction: Conversion of nitrate to nitrite and ammonia <u>Ammonia Assimilation: GS-GOGAT pathway, Reductive amination</u>	06
	1.2 Basics of Plant Stress	Transpiration: Introduction, Types, Mechanism: Starck-Sugar hypothesis, Significance system Concept of stress and strain; types of plant stress (abiotic and biotic); general stress responses Water stress: drought and water logging; osmotic stress and osmotic adjustment Temperature stress : heat chilling , freezing; heat shock proteins Salinity stress: causes, physiological effects and	08
2	Stress Physiology		
	2.1 Basics of Plant Stress	Concept of stress and strain; types of plant stress (abiotic and biotic); general stress responses Water stress: drought and water logging; osmotic stress and osmotic adjustment Temperature stress : heat , chilling Salinity stress: causes, physiological effects and tolerance mechanisms, freezing; heat shock proteins Salinity stress: causes, physiological effects and tolerance mechanisms	06
	2.2 Stress Tolerance and Adaptation	Antioxidant defense system: enzymatic and non-enzymatic antioxidants Role of phytohormones in stress tolerance: ABA, ethylene, salicylic acid, jasmonic acid Morphological and anatomical adaptations to stress Physiological and biochemical adaptations; compatible solutes and stress proteins	10
			30

COURSE OUTCOMES (COs)

- After successful completion of the course, students will be able to:
- Explain the concepts of plant metabolism, nitrogen fixation, nitrate reduction, ammonia assimilation, and transpiration mechanisms in plants.
- Analyze different types of plant stresses such as drought, salinity, temperature, and water logging, along with their physiological and biochemical impacts.
- Describe the role of antioxidants, phytohormones, stress proteins, and adaptive mechanisms

B0TANY-POLLUTION
Semester -VI
MAJOR PAPERS (Elective)
LABORATORY COURSE PRACTICAL
PLANT METABOLISM AND STRESS PHYSIOLOGY

Practicals:

1. Demonstration of anabolism and catabolism in Plants
2. Study of nitrogen deficiency symptoms in plants
3. Detection of nitrate in plant tissue (Qualitative test for nitrate using diphenylamine)
4. Detection of ammonium in plant extract (Qualitative test using Nessler's reagent)
5. Estimation of nitrate in plant material (Simple colorimetric method)
6. Demonstration of nitrate reductase activity (*In vivo* assay using leaf discs)
7. Study of root nodules in leguminous plants
8. Study of transpiration using cobalt chloride paper.
10. Effect of drought and water logging stress on seed germination
11. Effect of salinity stress on seed germination
12. Demonstration of heat stress on membrane permeability
13. Assay of enzymatic antioxidants (e.g. catalase activity) under stress conditions
14. Demonstration of non-enzymatic antioxidants (e.g. TPC) in plant tissues
15. Comparative study of stress tolerance and stress avoidance in plants

References:

1. Bhatla, S.C., & Lal, M.A. (2019). *Plant physiology, development and metabolism*. Springer Singapore.
2. Kochhar, S.L., & Gujral, S.K. (2020). *Plant physiology: Theory and applications* (2nd ed.). Cambridge University Press.
3. Taiz, L., & Zeiger, E. (2010). *Plant physiology* (5th ed.). Sinauer Associates.
4. Hopkins, W.G., & Hüner, N.P.A. (2009). *Introduction to plant physiology* (4th ed.). Wiley.
5. Salisbury, F. B., & Ross, C.W. (1992). *Plant physiology* (4th ed.). Wadsworth.
6. Sinha, R. K. (2003). *Modern plant physiology*. Narosa Publishing.
7. Gupta, D.K., & Palma, J.M. (Eds.). (2021). *Plant growth and stress physiology*. Springer.
8. Ahmad, P., & Prasad, M.N. V. (Eds.). (2012). *Abiotic stress responses in plants: Metabolism, productivity and sustainability*. Springer.
9. Raju, D., Rajendran, R.A., & Singh, V.P. (Eds.). (2024). *Phytohormones in abiotic stress*. CRC Press.
10. Peerzada, Y. Y., Shabir, A., & Hakeem, K.R. (Eds.). (2023). *Advances in plant nitrogen metabolism*. CRC Press.

11. Khan, M.N., Mobin, M., Firoz, F., & Corpas, F.J. (Eds.). (2014). *Nitric oxide in plants: Metabolism and role in stress physiology*. Springer.
12. Bhattacharya, A. (2017). *Abiotic stress and physiological process in plants*. NIPA.
13. Rao, K.V.M., Raghavendra, A.S., & Reddy, K.J. (Eds.). (2006). *Physiology and molecular biology of stress tolerance in plants*. Springer.
14. "Plant stress physiology". (n.d.). CAB International.
15. Ördög, V., & Molnár, Z. (n.d.). *Plant physiology* (PDFed.). [unpublished].
16. Mauseth, J.D. (2017). *Botany: An introduction to plant biology* (6th ed.). Jones & Bartlett Learning.
17. Lambers, H., Chapin, F. S., & Pons, T. L. (2008). *Plant physiological ecology* (2nd ed.). Springer.
18. Raven, P.H., Evert, R.F., & Eichhorn, S.E. (2005). *Biology of plants* (7th ed.). W.H. Freeman.
19. Kramer, P. J., & Boyer, J.S. (1995). *Water relations of plants and soils*. Academic Press.
20. Nobel, P.S. (2009). *Physicochemical and environmental plant physiology* (4th ed.). Academic Press.
21. Larcher, W. (2003). *Physiological plant ecology* (4th ed.). Springer.
22. Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. (2015). *Plant physiology and development* (6th ed.). Sinauer Associates.
23. Cramer, G.R., et al. (2011). *Plant adaptation to environmental stress*. Springer.
24. Zhang, J., & Jia, W. (2019). *Plant hormones and abiotic stress tolerance*. Wiley-Blackwell.

Semester-V
OPETIONAL ELECTIVE
Pollution Paper-V

OE: Environmental Perspectives in Tourism

CREDIT: 2

LECTURE PERIODS: 2PER WEEK

MARKS: 50

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Introduction to Ecotourism and Development		
	1.1 Introduction to Ecotourism and Evolution	Ecotourism Evolution, Principles, Trends and Functions of Ecotourism , Mass Tourism vs. Eco tourism, Ecotourism Activities & Impacts, Western Views of Ecotourism, Ecological Foot Prints. Relationship between Tourism & Ecology	06
	1.2 Alternative and Responsible Tourism Ecotourism, development	Sustainable Ecotourism. Resource Management, Socio-economic Development. Ecotourism Policies, Planning and Implementation. Eco-friendly Facilities and Amenities. Carrying Capacity, Alternative Tourism and Responsible ecotourism- Ecotourism Programming.	08
2	Eco Tourism Issues and Challenges		
	2.1 Eco Tourism Trends, Issues and Challenges	Conservation of Ecotourism Protected Area Management through Ecotourism. Community Participation - Types of Participation, Issues and Challenges - Ecotourism Projects - Case Studies on Thenmala Eco-Project, Similipal Ecotourism Project, Sunderbans Eco tourism Project, Nandadevi Biosphere Reserve.	06
	2.2 Role of National and International Agencies Ecotourism Development	Role of the International Ecotourism Society – the UNWTO, UNDP, WWF - Department of Forest and Environment - Government of India, ATREE, EQUATIONS	10
	Total Lectures		30

Learning Outcomes:-

1. Understand the concept, principles, functions and type of eco- tourism.
2. Identify activities and its impact on nature and environment..
3. Analyze the role of human activities in exacerbating environmental issues.
4. Evaluate and understand the responsibilities, issue and challenges, eco-tourism.
5. Gain the knowledge on sustainable eco-tourism and its socio- economic relevance,

Reference Books

1. Ralf C. Buckley Ecotourism – Principles and Practices
2. David A. Fennell Ecotourism
3. Jitendra K. Sharma Handbook of Environmental and Nature-Based Tourism
4. Luc Hens & An Thinh Nguyen Sustainable Tourism and Its Environmental and Human Ecological Effects
5. David Huddart & Tim Stott Adventure Tourism: Environmental Impacts and Management
6. Stephen F. McCool & Keith Bosak Reframing Sustainable Tourism
7. Stephen Wearing & Stephen Schweinsberg - Ecotourism
8. Jennifer Hill & Tim Gale- Ecotourism and Environmental Sustainability: Principles and Practice
9. Kelly Bricker & Jacqueline Kariithi Ecotourism and Sustainable Tourism: From Principle to Practice in the New Millennium
- 10 Ecotourism: Environment, Health and Education – Wei-Ta Fang, Arba'at Hassan & Max Horng

Vocational Skill Course (VSC)

SEMESTER-V

Pollution Paper II

Soil and Water Sampling

CREDIT: 2. PRACTICAL: 60 MARKS: 50

VSC: - Pollution Paper I Soil and Water Sampling

PRACTICAL

Soil and Water Sampling-I

1. Study of soil sampling tools
2. Collection of representative soil sample (surface soil and subsurface soil)
3. Composite soil sampling technique
4. Grid sampling method of soil
5. Study of Labeling, preservation and storage of soil samples
6. Preparation of soil samples for analysis
7. Determination of soil texture
8. Study of water sampling equipment
9. Collection of water samples from different sources
10. Preservation and storage of water samples
11. Interpretation of soil and water test reports
12. Determination of soil colour
13. Determination of soil moisture content and porosity.
14. Determination of total dissolved solids (TDS)
15. Determination of hardness of water

Course Outcomes:-

- To understand principles of soil and water sampling
- To learn standard sampling tools and methods
- To analyze basic physico-chemical properties
- To interpret soil and water quality for agriculture and environment

Vocational Skill Course (VSC)

SEMESTER-VI

Pollution Paper II: VSC

BIOFERTILIZER (Pollution control)

SEMESTER-VI

CREDIT: 2.

PRACTICAL HOURS: 60

MARKS: 50

PRACTICAL-II

1. Interpretation of experimental data related to Biofertilizer.
2. study the concept, types and importance of Biofertilizer
3. Identification of common Biofertilizer
4. To study carrier materials used in Biofertilizer
5. Sterilization techniques used in Biofertilizer production
6. Isolation of Rhizobium from root nodules of leguminous plants
7. Isolation of Azotobacter from soil using selective media
8. Isolation of Phosphate Solubilizing Bacteria (PSB) from soil
9. To study the application of different Biofertilizer on plant growth
10. Demonstration of Biofertilizer production through photographs/videos.
11. Field study report on visit to the vermicomposting facility / rice field / organic farm.
12. Survey of Biofertilizer usage by local farmers (field-based practical)
13. Graphical representation of plant growth data after Biofertilizer treatment
14. Study the root system of leguminous plants.
15. Study the morphology of Azolla.

Course Outcomes:-

1. Understand the principals of Biofertilizer farming
2. Analyze the importance of soil health in organic and Biofertilizer farming
3. Evaluate the use Role of Biofertilizer and their mechanism of action in agriculture
4. Develop the knowledge of soil management plan.
5. Acquire technical knowledge in Biofertilizer production technology

Semester –VI
SEC –III (Credit-2)

CREDIT: 2.

PRACTICAL HOURS: 60

MARKS: 50

Green Entrepreneurship and Eco-Friendly Products

PRACTICAL-II

1. Identification of plant materials used in eco-products
2. Preparation of natural dyes from plant sources
3. Preparation of organic compost
4. Preparation of vermicomposting
5. Preparation of eco-friendly paper bags
6. Preparation of cloth bags from waste cloth
7. Preparation of herbal floor cleaner
8. Preparation of herbal mosquito repellent
9. Preparation of biodegradable seed balls
10. Preparation of eco-friendly decorations
11. Study of local eco-friendly products in market
12. Survey of consumer awareness about eco-products
13. Preparation of business plan for eco-product
14. Preparation of project report on green entrepreneurship

Learning Outcomes-

- 1:** Understand the concept of green entrepreneurship and sustainable business.
- 2:** Identify natural resources useful for eco-friendly products.
- 3:** Prepare simple eco-friendly products using biodegradable materials.
- 4:** Develop small business ideas related to environmental products.
- 5:** Promote environmental awareness through sustainable products

Reference Books

1. Green Marketing and Entrepreneurship- Arne Nygard
2. Greener Products (2nd Edition)- Al Iannuzzi
3. Sustainability, Innovation, and Entrepreneurship- Andrea Larson
4. Green to Gold: How Smart Companies Use Environmental Strategy- Daniel C. Esty & Andrews Winston
5. Natural Capitalism: Creating the Next Industrial Revolution- Paul Hawken, Amory Lovins & Hunter Lovins
6. Green Innovations for Industrial Development and Business Sustainability- Ravindra Sharma, Geeta Rana & Shivani Agarwal

SEMESTER-VI

INDIAN KNOWLEDGE SYSTEMS (IKS)

Pollution Paper II: IKS

Environmental History and Ecology in Modern India

MODULE	SUB- MODULE	TOPICS	LECTURE PERIODS
1	Traditional Environmental Practices and Resource Management		
	1.1 Introduction to Traditional Environmental Practices	Traditional use of natural resources in India Traditional water management systems (tanks, wells, ponds) Community management of forests and water Decline of traditional environmental practices	06
	1.2 Colonialism and Water Resource Management	Water resource management during colonial period Development of large-scale canal irrigation Environmental effects of canal irrigation Changes in traditional water systems	08
2	Wildlife Management and Movements in Modern India		
	2.1 Wildlife Management	Hunting practices in ancient and medieval India Hunting during colonial period and its social aspects Wildlife conservation and establishment of national parks Human–animal conflicts around protected areas	06
	2.2 Environmental Issues and Movements in Modern India	Industrial use of forest resources (biomass and wood) Environmental problems caused by large dams Urban environmental issues: health, hygiene, waste disposal and air pollution Environmental movements in India ,Forest Conservation Act (1980) ,Forest Rights Act (2006)	10
	Total Lectures		30

Course Outcomes:-

After completing this course, students will be able to:

- 1: Understand traditional environmental practices and natural resource use in India.
- 2: Explain the impact of colonial policies on water resources and irrigation systems.
- 3: Describe the history of wildlife management and conservation in India.
- 4: Analyze environmental problems and environmental movements in modern India.
- 5: Understand major environmental laws related to forests conservation act, forest rights act.

Books recommended for IKS

1. "Ecological Restoration: Principles, Values, and Structure of an Emerging Profession" by Andre F. Clewell and James Aronson
2. The Society for Ecological Restoration (SER): A professional organization dedicated to advancing the science and practice of ecological restoration.
3. The International Union for Conservation of Nature (IUCN): A global organization that works to conserve and restore ecosystems.
4. The Ecological Restoration Alliance: A network of organizations and individuals working to advance ecological restoration.
5. Erach Barouche – *Textbook of Environmental Studies* Publisher: Universities Press
6. P. D. Sharma – *Ecology and Environment* Publisher: Rastogi Publications
7. P. S. Verma & V. K. Agarwal – *Environmental Biology* Publisher: S. Chand / Rastogi Publications
8. Mahesh Rangarajan – *India's Environmental History* Publisher: Oxford University Press
9. V. B. Saharia – *Wildlife in India* Publisher: Natraj Publishers
10. "Ecological Restoration: An International Journal" (a peer-reviewed journal)
11. "Restoration Ecology" (a peer-reviewed journal)
12. "The Encyclopedia of Ecological Restoration" by the Society for Ecological Restoration

SHIVAJI UNIVERSITY, KOLHAPUR
FACULTY OF SCIENCE
B.Sc.III POLLUTION
ON-THE-JOB TRAINING (OJT) AND FIELD PROJECT
(As per NEP, 2020)
SEMESTER –V&VI
SEMESTER –V

1. Course Title: **On-the-Job Training(OJT)and Field Project**
2. Course Code:.....
3. Credits: **04**
4. Total LearningHours:**120 Hours**
5. Semester: **Vth Semester.**
6. Course Type: Mandatory| Skill-based |Experiential Learning
7. Nature of Assessment: Internal Assessment Only
8. Total Marks: **100**

9. Course Rationale

In accordance with the National Education Policy (NEP) 2020 and the Internship/OJT guidelines of Shivaji University, Kolhapur, This course aims to integrate theoretical knowledge with real-life practical exposure. The On-the-Job Training (OJT) and Field Project provide undergraduate Pollution students with hands-on experience in academic, research, industrial, ecological, and community-based settings, enabling holistic learning and skill development.

10. Course Objectives

The objectives of this course are to:

1. Provide experiential learning through direct engagement with professional work environments.
2. Enable application of environmental conservation and protection related knowledge in laboratory, field, and industrial contexts.
3. Develop technical skills related to industrial pollution monitoring and control, EIA, ecology, biodiversity conservation.
4. Promote professional ethics, discipline, teamwork, and communication skills.
5. Enhance employability, entrepreneurship, and research aptitude among students

Course Outcomes (COs)

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

1. Demonstrate hands-on skills in environmental and industrial pollution monitoring field and laboratory techniques.
2. Apply theoretical concepts of Environmental conservation and protection to practical situations.
3. Collect, document, analyze, and interpret field data related to environmental and industrial pollution monitoring.
4. Prepare structured scientific OJT/Field Project report.
5. Communicate findings effectively through oral presentation and viva-voc

B.Sc.III
SEMESTER –VI
FIELD PROJECT
(As per National Education Policy, 2020)

1. Course Title: Field Project in Pollution
2. Course Code:(To be assigned by the University)
3. Credits:02Credits
4. Total Learning Hours:30Hours
5. Course Type: Research/ Field Study| Experiential Learning
6. Nature of Assessment: Internal Assessment
7. TotalMarks:50Marks

Course Objectives

1. To train students in environmental field survey techniques e.g.EIA.
2. To develop skills in identification of environmental problems and observation.
3. To introduce students to data collection and scientific documentation.
4. To promote awareness of environmental and biodiversity conservation.
5. To encourage independent research and report writing.

Course Outcomes (COs)

1. Conduct environmental field surveys and ecological observations.
2. Identify environmental problems and solutions.
3. Collect and analyze environmental and ecological data.
4. Prepare a scientific field project report.
5. Present research findings effectively

Suggested Field Project Areas Students may work on topics

- Plant Diversity of a region
- Study of any type of Ecosystem
- Study of ETP of any type of effluent discharge industry

- Study of any solid waste site and their management
- Study of Electricity audit /water audit/Kitchen waste
- Nursery management practices
- Conservation of rare plants
- Study of crop diseases
- Study of local plants and animal adaptations
- Study of natural disaster and impact on environment
- Any other suitable topic related to

subject

Component	Hours
Project Planning	5
Field Survey & Data Collection	35
Data Analysis	10
Report Writing	5
Presentation & Viva	5
Total	60 Hours

Field Project Report Format

1. Title Page
2. Certificate
3. Student Declaration
4. Introduction
5. Objectives
6. Study Area Description
7. Materials and Methods
8. Observations/ Data
9. Results
10. Discussion
11. Conclusion
12. Photographs/Field Evidence
13. References

Component	Marks
Field Work & Attendance	15
Data Collection & Analysis	10
Project Report	15
Presentation & Viva-Voce	10
Total	50

Field Project Certificate Format

CERTIFICATE

This is to certify that Mr./Ms.-----, Roll/Exam No. student
of

B.Sc.III POLLUTION ,-----College,affiliated to Shivaji
University,Kolhapur,has

Successfully completed the Field Project entitled as-----during the academic
year as part of the 2 Credit Course under NEP 2020

Nature of OJT/Field Project Work

Students shall complete OJT /Field Project in **any one** of the following approved areas:-

- Universities and Research Institutes
- Forest Department
- Environmental NGOs and Conservation Organizations
- Environmental Parameters analysis Laboratories
- Chemical and Textile Industries.
- Pharmaceutical Industries
- Agro-based Industries
- Any other related with subject

Duration and Hour Distribution

Component	Hours
Orientation and Planning	10
On-the-Job Training/ Field Work	80
Data Collection, Analysis & Report Writing	20
Presentation and Viva-Voce	10
Total	120 Hours

Guide lines for Students

1. Students must obtain prior approval from the Department and Course Coordinator.
2. OJT must be carried out at a recognized organization/industry/institution.
3. Maintain field diary is compulsory.
4. A completion certificate from the host organization is mandatory.
5. Students must follow institutional discipline and professional ethics.
6. Plagiarism in report writing is strictly prohibited.

OJT/Field Project Report Structure

1. Title Page
2. Certificate from Host Organization
3. Student Declaration
4. Introduction of Organization /Study Area
5. Objectives of OJT/Field Project
6. Methodology/ Nature of Data Collection Work
7. Observations and Results
8. Discussion
9. Learning Outcomes and Skills Acquired
10. Conclusion
11. Photographs/Field Evidence
12. References

Scheme of Evaluation (Internal –100Marks)

Component	Marks
Attendance, Discipline&Logbook	30
OJT/FieldProjectReport	30
Presentation/Seminar	20
Viva-Voce	20
Total	100 Marks

Detailed Evaluation Rubrics

A. Attendance, Discipline & Logbook (30Marks)

Criteria	Excellent (26–30)	Good (21–25)	Satisfactory (16–20)	Poor (≤15)
Regularity& Punctuality	Fully regular	Minor lapses	Occasional absence	Irregular
LogbookMaintenance	Complete, neat	Minorerrors	Incomplete	Poor
Professional Behaviour	Highly professional	Cooperative	Needs improvement	Unprofessional

B. OJT/FieldProjectReport(30Marks)

Criteria	Excellent	Good	Satisfactory	Poor
Structure&Organization	Scientific	Organized	Average	Poor
Content & Relevance	In-depth	Adequate	Limited	Poor
Data& Analysis	Accurate	Relevant	Basic	Inadequate
Language&Presentation	Clear	Minor errors	Average	Poor

C. Presentation/Seminar(20Marks)

Criteria	Excellent	Good	Satisfactory	Poor
Clarity&Confidence	Excellent	Good	Average	Poor
Subject Knowledge	Thorough	Good	Basic	Inadequate
UseofVisual Aids	Effective	Adequate	Minimal	None

A. Viva-Voce(20Marks)

Criteria	Excellent	Good	Satisfactory	Poor
Conceptual Understanding	Strong	Good	Basic	Poor
Applicationof Knowledge	Excellent	Good	Limited	Nil
Communication Skills	Clear	Adequate	Hesitant	Poor