DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/B.Sc./CBC & GS/08/2024

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies/Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted the following Syllabi under the Faculty of Science & Technology as per Choice Based Credit Grading System** as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc. Environmental Science (Optional)	Ist to VIth semester
2.	B.Sc. Fishery Science (Optional)	Vth & VIth semester
3.	B.Sc. Biochemistry (Optional)	Vth & VIth semester

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2024/1171-79
Date:- 18.06.2024.

* * * * *

Deputy Registrar,
Academic Section

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1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

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1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

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Dr.BabasahebAmbedkarMarathwadaUniversity

Chhatrapati Sambajinagar-431004(MS)India

Undergraduate Bachelor Degree Program in Science (B.Sc.)

Environmental Science(Optional Subject)

First Year, Second Year & Third Year

Course Structure and Curriculum

(Outcome based Curriculum)

Choice Based Credit System

Effective From the Academic Year 2022-23, 2023-24 & 2024-25/-

Dr. Babasaheb Ambedkar Marathwada University

Chhatrapati Sambajinagar– 431004 (MS) India

INDEX

Sr.No.	Contents	Pg.No.
1	Preamble	1-2
2	CourseStructure	5-10
3	Vision	
4	Mission	
5	ProgramEducationalObjectives	
6	Program Out come and Programme Specific Outcomes	
7	Eligibility	
8	Duration	
9	MediumofInstructions	
10	ChoiceBasedCreditSystem, Credit-to-ContactHourmapping…	
11	Attendance	
12	EvaluationMethods/Schemeof Examination,EarningCredits,GradingSystem	
13	Curriculum:Semester–I	
14	Curriculum:Semester–II	
15	CurriculumSemester –III	
16	CurriculumSemester –IV	
17	CurriculumSemester –V	
18	CurriculumSemester –VI	

1. Preamble

The course curriculum for undergraduate studies under choice-based credit system (CBCS) for B.Sc. in Environmental Science is framed in this document. This exercise was undertaken as part of the nationwide curriculum restructuring initiative by the National Education Policy.

As enshrined in the National Education Policy vision of introducing course curriculum for undergraduate studies under Choice Based Credit System (CBCS), the main objective of framing this curriculum of B.Sc. in Environmental Science is to impart the students a holistic understanding of the subject giving substantial weightage to the core contents, skill, value-based and ability enhancement. The syllabus has given due importance on the main streams of the body of knowledge on 'Environment' with due recognition of its wide spectrum. The ultimate goal of the syllabus is to enable the students to have an in-depth knowledge on the subject and enhance their scope of employment at every level of exit. Adequate emphasis has been given on the new and emerging techniques and understanding of the subject under the changing regime and global context.

There is need to strengthen the students to understand essential aspects of environmental science in diverse subject areas such as ecology, environmental chemistry, environmental pollution, environmental geo-science, atmospheric sciences, biodiversity, natural resources management, global warming, climate change and waste management. The curriculum lays focus on creating new knowledge, acquiring new skills and capabilities in Environmental Science producing an intelligent human resource serving the Environment and society, focusing on problem solving critical thinking, team work and collaboration. There is also an additional emphasis in providing opportunities to understand the integration of modern disciplines such as environmental modeling, geographical information systems and remote sensing, environmental sustainability, corporate governance and their applications to environmental sciences. Students would be encouraged to go beyond the classroom and conduct active action-research, research projects, technology-based learning and internships in industry/ private/government/manufacturing and service sectors based on suitability. Lectures and classroom sessions are accompanied with on-field visits, industrial visits, seminars, laboratory experiments and in-plant training. Educational visits are an integral part of teaching Environmental Science. These interventions are compulsory and essential aspects of the curriculum. There are optional subject that can be chosen by the students as per their desire and their professional choices. It is hoped that a student with a four years B.Sc. Environmental Science degree, after having the rigor of the courses outlined here, will feel adequately equipped to meet the challenges of career development. At the same time, there is sufficient content for those who wish to continue academic life at the University beyond the under-

graduate level. Due care has been taken to maintain necessary academic wholesomeness and depth in the course content so that the learning outcomes from these courses will lead to intellectual growth of a student. The need for a Basic course in Environmental Sciences is necessitated by our country's requirement and also the acceptability of the subject by young students from the view point of career opportunity. There is a demand for the subject in our country and as Educationists we have a societal obligation to meet such aspirations of the youths. It is equally expected that Environmental Science graduates will significantly contribute to the vision of 'Zero Defect, Zero Effect' policy initiative of Government of India.

2. StructureandCurriculumfor Bachelorof Science(B.Sc.) In Environmental Science (OptionalSubject) (ChoiceBasedCreditSystem)

Dr.BabasahebAmbedkarMarathwadaUniversity, Aurangabad

ChoiceBasedCreditSystem(CBCS)CurriculumFor

Facultyof ScienceandTechnology

CourseStructureandSchemeofExamination

B.Sc.ThreeYearUndergraduate Degree Program

SemesterI

	CourseCode	Course Title	Total periods(Teachingperiods/week)	Credits	Schemeof Examination			
					Max Marks	CIA	UA	Min Marks
Optional I(DSC-1A) Core Courses	EVS-111	Core Course (TheoryPaper-I) Foundation of Environment	45(3/week)	2	50	10	40	20
	EVS –112	Core Course (TheoryPaper-II) Chemical Aspects of Environment	45(3/week)	2	50	10	40	20
	EVS -121	Lab course I (Based onEVS -111 andEVS-112)	45(3/week)	1.5	50	10	40	20
AbilityEnhancement compulsorycourses(AECC-1)	XXX-131	CommunicationskillsinEnglish-I	45(5/week)	3	50	10	40	20
	XXX-132	Marathi/Hindi/Urdu/Sanskrit A student can opt for any one ofthese languages(SL-I)	45(4/week)	3	50	10	40	20
			225	11.5	250	50	200	100

TotalCredits forSemesterI:11.5(Theory :10;Laboratory:1.5)

SemesterII								
	Course Code	Course Title	Total periods(Teachingperiods/ week)	Credits	Schemeof Examination			
					Max Marks	CIA	UA	Min Marks
Optional I(DSC-1B) Core Courses	EVS-211	Core Course (TheoryPaper-III) Natural Resources Management	45(3/week)	2	50	10	40	20
	EVS-212	Core Course (TheoryPaper-IV) Solid waste and Hazardouswaste management	45(3/week)	2	50	10	40	20
	EVS -221	Lab course2 (based onEVS - 211 and EVS -212)	45(3/week)	1.5	50	10	40	20
AbilityEnhancement compulsorycourses(AECC-2)	XXX-231	CommunicationskillsinEnglish-II	45(5/week)	3	50	10	40	20
	XXX-232	Marathi/Hindi/Urdu/Sanskrit A student can opt for any one ofthese languages(SL-II)	45(4/week)	3	50	10	40	20
Non-CreditCourse	XXX-213	ConstitutionofIndia	45(3/week)	2*	50			
Non-Credit Course /additional credits	XXX-214	CompulsoryComputerCourse	45(3/week)	2*	50			
			225	11.5	250	50	200	100
TotalCredits forSemesterII:11.5(Theory :10; Laboratory:1.5)								
SemesterIII								
	Course Code	Course Title	Total periods(Teachingperiods/ week)	Credits	Scheme of Examination			
					Max Mark	CIA	UA	Min Marks
Optional I(DSC-1C) Core Courses	EVS -311	Microbiological aspects of Environment (TheoryPaper-V)	45(3/week)	2	50	10	40	20
	EVS -312	Soil, Health and remediation measures (TheoryPaper-VI)	45(3/week)	2	50	10	40	20
	EVS -321	Lab course 3 (BasedonEVS -311)	45(3/week)	1.5	50	10	40	20
	EVS -322	Lab course 4 (Based onEVS -312)	45(3/week)	1.5	50	10	40	20
Skill Enhancement course(SEC-1)	EVS-313-A	Organic Farming	45(3/week)	2	50	10	40	20
	EVS-313-B	Agricultural Waste Management	45(3/week)	2	50	10	40	20
AbilityEnhancement compulsorycourses(AECC-3)	XXX-331	CommunicationskillsinEnglish-III	45(5/week)	3	50	10	40	20
	XXX-332	Marathi/Hindi/Urdu/Sanskrit A student can opt for any one ofthese languages(SL-III)	45(4/week)	3	50	10	40	20
			315	15	350	70	280	140
TotalCreditsforSemesterIII: 15(Theory:12; Laboratory:3)								

SemesterIV								
	Course Code	Course Title	Total periods(Teachingperiods/week)	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I(DSC-1D) Core Courses	EVS-411	Air Pollution control technology (TheoryPaper-VII)	45(3/week)	2	50	10	40	20
	EVS-412	Water Management (TheoryPaper-VIII)	45(3/week)	2	50	10	40	20
	EVS-421	Lab course5 (Based onEVS-411)	45(3/week)	1.5	50	10	40	20
	EVS-422	Lab course6 (Based onEVS-412)	45(3/week)	1.5	50	10	40	20
SkillEnhancementcourse (SEC-2)	EVS-413-A	Air Quality Management	45(3/week)	2	50	10	40	20
	EVS-413-B	Water Quality Management	45(3/week)	2	50	10	40	20
AbilityEnhancement compulsorycourses(AECC-4)	XXX-431	CommunicationskillsinEnglish-IV	45(5/week)	3	50	10	40	20
	XXX-432	Marathi/Hindi/Urdu/Sanskrit A student can opt for any one of these languages(SL-IV)	45(4/week)	3	50	10	40	20
Additional credits		Environmental Studies	45(3/week)	2*	50	10	40	20
			315	15	350	70	280	140
TotalCredits forSemesterIV:15(Theory:12; Laboratory:3)								

SemesterV								
	Course Code	Course Title	Total periods(Teachingperiods/week)	Credits	Schemeof Examination			
					Max Marks	CIA	UA	Min Marks
Optional I(DSE-1A) Discipline Specific Elective	EVS- 511	Water Pollution (Theory Paper-IX)	45(3/week)	2	50	10	40	20
	EVS- 512	Treatment Technology (Theory Paper-X)	45(3/week)	2	50	10	40	20
	EVS- 521	Lab course 7 (BasedonEVS-511)	45(3/week)	1.5	50	10	40	20
	EVS- 522	Lab course 8 (Based onEVS-512)	45(3/week)	1.5	50	10	40	20
SkillEnhancement course(SEC-3)	EVS-513-A	Impact of Water Pollution on Ecosystem	45(3/week)	2	50	10	40	20
	EVS-513-B	Water and Waste water Treatment Processess	45(3/ week)	2	50	10	40	20
		SEC-3Any one skill to be chosen out oftwoSEC-3(E), SEC-3(F)						
			225	9	250	50	200	100
TotalCreditsforSemesterV: 9(Theory:06; Laboratory: 03)								

SemesterVI								
	Course Code	Course Title	Total periods(Teachingperiods/week)	Credits	Schemeof Examination			
					Max Marks	CIA	UA	Min Marks
Optional I(DSE-1B) Discipline Specific Elective	EVS-611	Environmental Toxicology (Theory Paper-XI)	45(3/week)	2	50	10	40	20
	EVS-612	Industrial and laboratory safety (Theory Paper-XII)	45(3/week)	2	50	10	40	20
	EVS-621	Labcourse9 (basedonEVS-611 & EVS-612)	45(3/week)	1.5	50	10	40	20
	EVS-622	Labcourse10 (Project work, Industrial Visit Report, Study Tour Report & Seminar)	45(3/week)	1.5	50	10	40	20
Skill Enhancement course (SEC-4)	EVS-613A	Environmental Audit	45(3/week)	2	50	10	40	20
	EVS-613A	Composting From Solid Waste	45(3/week)	2	50	10	40	20
			225	9	250	50	200	100
TotalCredits forSemesterV:09(Theory:06; Laboratory:03)								
TotalCreditsfor three years: Sem I (11.5) + SemII (11.5) + SemIII (15) +SemIV (15) +SemV (09) +SemVI (09)=71Credits								

3. **Vision**
4. **Mission**
5. **ProgramEducationalObjectives:**
6. **Programme Outcomes(Pos) and Programme Specific Outcomes:**
7. **Eligibility:**
8. **Duration**
9. **Mediumof Instructions**
10. **Choice Based Credit System (CBCS) and Credit-to-contact hourMapping:**
11. **Attendance:**
12. **Evaluation Methods/ Scheme of Examination, Earning Credits, GradingSystem**
13. **CurriculumforSemesterI**
14. **CurriculumforSemesterII**
15. **CurriculumforSemesterIII**
16. **CurriculumforSemesterIV**
17. **CurriculumforSemesterV**
18. **CurriculumforSemesterVI**

Templateforthe designingcurriculumofvariouscourses/papers

CourseCodeand CourseTitle

TotalCredits:02

Contact Hours: 30 (ClockHours)

Marks:50

Periods: 45 (50 minutes each)

LearningObjectivesoftheCourse

LearningOutcomesoftheCourse

Unit I:10 PeriodsUnit II:10

PeriodsUnit III:10

PeriodsUnitIV:10Periods

Unit V: Tutorials, seminars and Assignments (05periods)
References:ImportantNotes:

i) **Nomenclature**: DSC-DisciplineSpecificCorecourse,SEC–Skill Enhancement Course, AECC-Ability Enhancement compulsorycourse, DSE-DisciplineSpecificElective,UA-UniversityAssessment(SemesterEnd), CIA-ContinuousInternalAssessment

ii) There shall be one skill enhancement course (SEC) IIIrd to VIth Semester (any one SECcourse to be chosen (any one from three optional subjects) from the basket of SEC coursesfortherespectivesemester.

iii) **Code description: EVS**codehastobedecidedbyBOSoftherespectivesubjectwhiledesigningtheir respectivecurriculum(e.g. for Environmental ScienceitwillbeEVS)

- Thecodesforfirstsemestercourseswillstartfrom EVS-111, Second-semestercourseswillstartfrom EVS-211 and so on
    - EVS111: Thefirstdigit indicates theSemesterNumber; the secondtwodigitsindicatepapernumbersfor thefirst-semestercoursesandthesameanalogyisfor the remainingsemesters
    - Thecodesfortheorycourseswillstartfrom EVS - 111(forthefirstsemesterandthesameanalogyis fortheremaining semesters)
    - Thecodesforpracticalcourseswillstartfrom EVS - 121(forthefirstsemesterandthesameanalogyis fortheremaining semesters)
    - ThecodesforAbilityEnhancementcompulsorycourseswillstartfrom EVS -131(forthefirstsemesterand thesameanalogy is for theremaining semesters)

iv) **Assessment**:80%forUniversityAssessment (SemesterEnd Examination) and20 %forContinuousInternalAssessment(CIA)

v) **Continuous Internal Assessment (CIA): Theory** (10 Marks): Internal Test 05 Marks (TwoInternalTestsof05markseachandaverageof thetwo tests willbe considered) and05MarksforAssignment/tutorials.

vi) **ContinuousInternalAssessment (CIA): Practical**(10Marks): 07MarksforInternalPracticalExamination and 03 Marks for record book/submission of collection and field survey report andexcursion report

vii) **Practical examination:**Annualexamination

B. Sc. I Year, Semester I
Core Course (TheoryPaper-I)

EVS- 111: Foundation of Environment

Course Objectives

Students will be able to know

1. Dynamics of ecosystems, energy flow in ecological system, nature of a biotic and biotic components and stability concept of ecosystem.
2. Various types of degraded ecosystems, ecological succession, concept of climax and role of pioneer's species in restoration of ecosystems.
3. Population dynamics, prey predator relationship, concept of community, community competition and ecological sustainability.
4. Nature and status of renewable and non-renewable resources, mineral resources, fishery resources, energy resources and recycle, reuse and recovery of these resources.

Unit-I: - Ecosystem Dynamics: (10)

Concept of ecosystem, A biotic and biotic components, Energy in ecological system, Concept of productivity, Energy flow in ecosystem, Food chain, Food web, Ecological pyramids, Biogeochemical cycles of nitrogen, oxygen and carbon.

Unit –II: Ecological succession (10)

Types of ecological succession, Mechanism of succession, Concept of climax, Concept of Gaia hypothesis. Concept of habitat, Ecological niche, Guild, concept of ecotone, Edge effect. Significance of ecological adaptation, Ecological adaptation in plant- Hydrophytes, Xerophytes, Mesophytes and Halophytes.

Unit-III: -Restoration of Degraded Ecosystems: **(10)**

Degraded ecosystems such as, Forest, grassland, Desert ecosystem, Lentic and Lotic ecosystems, Coastal ecosystems, etc., Role of pioneer species in restoration, Major biomes of world.

Unit-IV: - Population and Community Ecology: **(10)**

Concept of population ecology, Population dynamics, Characteristics of population: Natality, Mortality, Fecundity, Density, Age distribution, Prey predator Relationship, Population explosion: Concept of community, Interspecific and intraspecific competition, Concept of carrying capacity.

Unit-V: Tutorials, seminars and Assignments (05)

Course Outcome

Students should able to:

1. Define ecological systems and its functionality along with stability concept of ecosystem
2. Describe various types of pioneer species and their role in restoration of ecosystems.
3. Recognize ecological succession, concept of climax and degraded ecosystem.
4. Examine nature and status of renewable and non renewable energy resources, mineral resources and energy resources.

References

1. Fundamentals of Ecology – E.P. Odum, Revised Edition 1995-96
2. Principles of Ecology – P.S. Verma, V.K. Agarwal, S. Chand and Co. Delhi.
3. Principles of Environmental Science – Wart K.E.F. (1973) McGraw Hill Book Company.
4. Basic Ecology – E.P. Odum
5. Concept of Ecology – E.J. Koromondy, 1996, concept of modern biology series, prentice Hall.
6. Modern Concepts of Ecology – H.D. Kumar
7. Principles of Environmental Biology – P.K.G. Nair, Himalaya pub. House, Delhi
8. Environmental Biology – P.D. Sharma, Rastogi Publication, Meerut.
9. Ecology and Environment – P.D. Sharma, Rastogi Publication, Meerut.
10. Basic concepts of soil science – A.K. Kolay, Willey estern ltd., New Delhi.
11. Environmental Science – Enger, Smith, Smith, W.M.C. Brown company publishing
12. Practical Method in Ecology – R.K. Trivedi, P.K. Goel and Trisal.,Enviro Publication, Karad.
13. Chemical methods for Environmental Analysis Water and sediments – R.Ramesh, M. Anbu. Macmillan India Ltd. New Delhi.
14. Fundamental of Ecology – Dash M.C. Tata McGraw Hill Pub. Co. Ltd. NewDelhi.
15. Concepts of Ecology (Fourth Edition)- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
16. Environment forest, ecology and man – Dixit R.K. Rastogi Publication, NewDelhi.
17. Environment, energy, health planning for conservation – V. Vidyanath, Gyan Publishing House, New Delhi
18. Air pollution-M.N. Rao
19. Air pollution- A.C. Stern, Academic press Vol. I-X.
20. Air pollution-V.P. Kudesia.
21. Air pollution control-NEERI
22. Air pollution-Magill Holder and Ackely
23. Water pollution-A.K. Tripathi and S.N. Pande
24. Waste water engineering, treatment, disposal and reuse-Metcalf and Eddy.
25. water supply and sanitary engineering-R.C. Rangwala

B. Sc. I Year, Semester I

Core Course (TheoryPaper-II)

EVS-112: Chemical Aspect of Environment

Course Objectives

Students will be able to know

1. Understand the basics concepts of Chemistry
2. Acquire the knowledge of composition of Air, Water & Soil
3. Identify the chemical aspects of Environment.
4. To analyze processes for Air, Water & Soil

Unit-I: -Basic Concepts of Environmental Chemistry: **(10)**

Energy-definition, types (kinetic and potential), Forms of energy: Laws of thermodynamics (First & Second), Stoichiometry, Gibbs energy, Chemical potential, chemical equilibrium, Acid-base reactions. Solubility product, Solubility of gases in water.

Unit-II: - Chemical Agents in Environment: **(10)**

Introduction, definition, Scope, Importance, Role of chemical agents in environment, Basic water chemistry, Impurities, Basic principles and sources, Gases solubility in water, Heat influencing chemical reactions, Solubility of impurities, Characteristics of sanitary spent water, Concentration, Normality, Molarity, concept of dilution, Serial dilution, Single step and multiple step dilution, Sample collection guidelines, Sample preservation, Sample order.

Unit–III:Chemistry of Air : (10)

Classification of elements, Composition of air, Chemical speciation, particles, Ions and radicals in the atmosphere, Chemical processes for formation of inorganic and organic particulate matter, Toxic chemicals in environment, Pesticides, Insecticides, Arsenic, Cadmium, Lead, Mercury, Carbon monoxide and Ozone, MIC and other carcinogens in air and water.Chemistry of Ozone layer, Ozone layer depletion, Causes and effects. Greenhouse effect: Major greenhouse gases, Causes and effects. Global Warming, Causes and effects.

Unit –IV: - Chemistry of Water and Soil: (10)

Chemistry of water, Structure of water molecule, Solubility of compounds in water, dissociating constant, Water quality parameters and standards, Chemistry of soil, Composition of soil, Biogeochemical cycles (nitrogen, oxygen,carbon,Sulphur, phosphorus etc.), Micronutrients of soil, Factors effecting the soil quality, Adsorption of contaminant in soil, Toxic chemicals present in soil.

Unit V: Tutorials, seminars and Assignments **(05)**

Course Outcome

Students should able to:

- Define basics aspects of environment
- Explain chemical contamination in the environment
- Apply the knowledge of chemistry to analyze air, water and soil quality
- Evaluate the level of pollution in environment

References

1. Environmental Chemistry- G.S. Sodhi.
2. Environmental Science –S.C.Santra
3. Environmental Chemistry- S. E.Mannhan
4. Environmental Chemistry – A.K. De
5. Environmental Chemistry-A global perspective; G.W. Vantoon and S.J. Duffiy, Oxford Uni. Press, London.
6. Environmental chemistry – B.K. Sharma
7. Environmental chemistry – B.K. Sharma and H. Kaur
8. Environmental pollution analysis – S.M. Khopkar
9. Environmental chemical analysis – Lanin L. Marr, Malcom S.
10. Environmental Chemistry – Kanan Krishnan.
11. Environmental Chemistry – S.K. Banerjee.
12. Environmental Chemistry – J.W. Moore and E.A. Moore.
13. Destruction of hazards chemicals in the laboratory: G. Lunn and E.B. Sansone.
14. A text book of Environmental Chemistry and pollution control – S.S. Dara.
15. Environmental Chemistry – M. Satake, Do. S. Sethi, S.A. Eqbal.
16. Environmental and Man: The chemical environmental: J. Lenihan and W.W. Fletcher.
17. Environmental Chemistry – S.S.Dara

B. Sc. I Year, Semester I

EVS-121: Lab Course- 1

(Practical paper based on paper EVS-111 and EVS-112)

1. To study the 'Laboratory Safety Rules'.
2. To study the cleaning methods of glass wears.
3. To study the First-Aid and emergency treatment in laboratory.
4. Collection and Preservation of phytoplankton and zooplankton samples from different Water bodies (river, pond, Lake etc)
5. The qualitative study the phytoplankton's (any 10 specimens).
6. The qualitative study the zooplanktons (any 10 specimens).
8. Collection of hydrophytes, xerophytes, mesophytic and halophytic plants / animals Specimens.
9. Study of xeric adaptation in plants, morphometrically and histologically.
10. Study of xeric adaptations in animal (at least 5 specimen's morphometrically)
11. Study of mesophytic specimens (at least 5 specimens).
12. To study the laboratory equipment's and instruments (Oven, Microscope, Incubator, Inoculation chamber, Autoclave, Electronic balance, pH meter, Colorimeter, Turbidity meter, etc).
13. To study the preparation of regents of different Normality and Molarities (i.e. 1 N, 0.1N,1M, etc).
14. Study of various equipment's used in air pollution.
15. Detection of SO2 gas and its effect on plants.
16. Detection of NH3 gas and its effect on plants.

Note:

B) Duration for each practical is of 04 periods.

ii) Study tour /field visits are compulsory.

B. Sc. I Year, Semester II
Core Course (TheoryPaper-III)

EVS- 211: Natural Resources Management

Unit I: Natural Resources: (10)

Definition; Classification; Concept of renewable and nonrenewable resources; their conservation and importance, Role of Individuals and NGOs in Resource Conservation: Environmental movements such as 'Chipko', Western Ghats, and Silent valley, Narmada, Project agitation etc.; Role of individuals and NGO's in natural resource conservation.

Unit II: Energy Resources: (10)

Renewable and non-conventional energy resources like solar, wind, geothermal, tidal and wave energy, biomass, biogas and biodiesel, hydroelectric energy; Atomic energy, on-renewable and conventional energy resources like coal, petroleum, fuel gases; Environmental impacts of energy exploitation, Energy conservation.

Unit IV: Forest and Wildlife Resources: (10)

Importance of forests and wildlife; Types of forest resources; Overexploitation of forests; Deforestation; Forest management and conservation; Wildlife conservation; National parks and sanctuaries; Biosphere reserves.

Unit IV: a) Water Resources and conservation: (10)

Water resources on the earth; Consumption and uses of water; Management and conservationof water resources; Rain water harvesting, drip irrigation.

b) Mineral and Soil Resources:

Types and Importance of minerals and soil; Important minerals of India; Mineral extraction and environmental problems; Conservation of mineral resources; Reclamation of mining areas. Soil erosion, conservation of soil.

Unit V:Tutorials, seminars and Assignments (05)

References:

1. Environmental Chemistry – B.K.Sharma
2. Ecology and Environment – P.D Sharma
3. Geography of India – Majid Hussain
4. Environmental Studies- Arun K.Tripathi
5. Environmental Geography- Savindra Singh
6. Oceanography- Savindra Singh
7. Environmental studies -ErachBharucha
8. Environmental studies –Irani Dipti
9. Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. Resources of the Earth: Origin, Use, and Environmental Impacts (2nd edition). Prentice Hall, New Jersey.
10. Freeman, A.M. 2001. Measures of value and Resources: Resources for the Future. Washington DC.
11. Freeman, A.M. 2003. Millennium Ecosystem Assessment: Conceptual Framework. Island Press.
12. Ginley, D.S. &Cahen, D. 2011. Fundamentals of Materials for Energy and
13. Environmental Sustainability. Cambridge University Press.
14. Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publication.
15. Miller, T.G. 2012. Environmental Science. Wadsworth Publishing Co.
16. Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
17. Tiwari, G.N. & Ghosal. M. K. 2005. Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House.

B. Sc. I Year, Semester II

Core Course (Theory Paper-IV)

EVS- 212: Solid waste and Hazardous waste management

Unit I- Introduction (10)

Introduction to MSW, Composition and Waste characteristics of MSW, Collection, Segregation and Transfer Operation, Waste system, current scenario, MSW generation in India, Model for appropriate waste collection and segregation, reference model, mode of collection, micro-route planning and maps, transfer stations, Management and Handling Rules of MSW.

Unit II- Treatment Method for MSW (10)

B. Anaerobic Digestion, 2. Aerobic Digestion, 3. Vermicomposting, 4. Incineration, 4) Mass Burn and Refuse-Derived Fuel, 5. Waste To Energy (WTE), Dioxin and furans, heavy metals, 6. Landfill (Basic Landfill Constructions and operations, Decomposition and phases in Landfill) Types landfills (Secured Landfill, Sanitary Landfill).

Unit III- Integrated Solid Waste Management (10)

Source Reduction, Green, Material Selection, Product System Life Extension, Material Life Extension, Reduced Material Intensiveness, Process Management, Efficient Distribution, Eco-labels, Lifecycle Assessment, The 5 R's-Reduce, Recycle (Paper & Paperboard, Plastics, Glass Containers, Aluminum), Reuse, Remanufacture, Recovery (Energy Recovery & Material Recovery)

Unit- IV- Hazardous waste Sources and Management (10)

Hazardous Waste Management: Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations –minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e- waste -sources, collection, treatment and reuse management. Hazardous waste treatment: Hazardous waste treatment technologies, Biomedical Waste management: Biomedical (Handling and Management) Rules 2008, sources and disposal.

Unit-V- Tutorials, seminars and Assignments (05)

B. Sc. I Year, Semester II

EVS-221: Lab Course- 2

(Practical paper based on paper EVS-211 and EVS-212)

1. Measurement of Electrical Conductivity.
2. Determination of Total Hardness.
3. Determination of Dissolved Oxygen.
4. Determination of Alkalinity
5. Determination of Free CO_2
6. Determination of Turbidity.
7. Determination of soil Temperature.
8. Determination of Soil Moisture
9. Determination of soil pH.
10. Determination of organic matter in soil .
11. Monitoring wind speed and direction.
12. To study the Vermicomposting bed.
13. Determination pH & Electrical conductance of Municipal solid waste.
14. Determination of Moisture content of municipal solid waste.
15. Determination of potassium of Municipal solid waste.
16. Percent composition study of solid waste for organic and inorganic matter.

References

1. George Tchobanoglouset.al., "Integrated Solid Waste Management", McGraw-Hill Publishers, 1993. 177
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, "Waste Management", Springer, 1994.
3. Municipal Solid Waste Management – N. N. Bandela, D.G.Tare,B.R.Publishing Corporation,2009
4. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
5. R.E.Landreth and P.A.Rebers, "Municipal Solid Wastes –problems and Solutions", Lewis Publishers, 1997.
6. Bhide A.D. and Sundaresan, B.B., "Solid Waste Management in Developing Countries", INSDOC, 1993.
7. George Tchobanoglouset.al., "Integrated Solid Waste Management", McGraw-Hill Publishers, 1993. 177
8. B. Bilitewski, G. HardHe, K.Marek, A.Weissbach, and H.Boeddicker, "Waste Management", Springer, 1994.
9. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
10. R.E.Landreth and P.A.Rebers, "Municipal Solid Wastes –problems and Solutions", Lewis Publishers, 1997.
11. Bhide A.D. and Sundaresan, B.B., "Solid Waste Management in Developing Countries", INSDOC, 1993.
12. Gilbert Masters, "An Introduction of Environmental Engineering", McGraw-Hill Publishers.
13. Dr. P.K Behra , Dr. S.K. Sahu and M.S. Shivarama, "Encyclopedia of Hazardous Waste Management", Dominate Publishers and Distributers.

B. Sc. II Year, Semester III

EVS-311: Microbiological aspects of Environment

(TheoryPaper-V)

Course Objectives

Students will be able to know

1. Student will know the concept of microbiology, its scope and status in India.
2. Students will be able to assess the role of microbiological tools in pollution abatement.
3. Students will be able to know and plan for different bioremediation and phyto-remediation techniques for control of pollutants.
4. Student will be able to know the role, regulation of bio-safety protocols and development of transgenic research in India.

Unit-I: Introduction: - **(10)**

Definition, Branches of Microbiology, (Industrial, Medical, Mycology, Environmental microbiology), History of Microbiology b). KingdomProtista: Concepts and classification of: Prokaryotes (Bacteria and Cyanobacteria) Eukaryotes (Algae, Fungi and Protozoans)

Unit-II: Bacteria: **(10)**

Morphology and general characters, Classification of bacteria based on temperature, pH, oxygen requirement, Carbon and energy source. Growth of bacteria.

Unit-III: Viruses: **(10)**

Morphology, General characters of viruses, Distribution (Animal, Plant and Bacteriophage viruses).

Diseases caused by contaminated water: - Introduction and Sources- Water borne bacterial diseases with their causal organism, symptoms, prevention and control measures: Cholera, typhoid, Shigellosis.

Unit-IV: **(10)**

a) Pure culture: Concept, Preparation and Preservation,

b) Control of microorganism: - Sterilization and disinfection Physical agents (Heat, Radiation, Filters),- Chemical agents (Acid, Ethylene oxide, Alcohol and heavy Metals)

c) Definition and concept of vaccinations: Antigen and Antibodies as preventive measures against microbial diseases

Unit – V: Tutorials, Seminars and Assignments **(05)**

Course Outcome

Students should able to:

1. Define microbiology and its functionality along with stability of microbiology.
2. Describe various types of microbiological aspects and their role in restoration of ecosystems.
3. Examine nature and status of microorganisms

References

1. Fundamentals of Microbiology- Pelczer Pub.
2. Elements of Microbiology-Pawar and Daginawala (Vol.I,II)
3. Microbiology-P.D.Sharma.
4. Environmental Microbiology- Vijay Ramesh , M.J.P.Pub.
5. Role of Microbes in Management of Environmental Pollution-edited by R.Tiwari.
6. Practical Microbiology-R.C. Dubey, D.K.Maheshwari, S.Chand Pub.
7. Elements of Bio-technology-B.D.Singh.
8. Soil Microbiology-Pawar and DaginwaleMicrobiology-P.D. Sharma , Rastogi publisher, meerut
9. Fundamental principle of bacteriology-P.C.Salle
10. Microbiology-Pelczar, M.S. Chand.
11. Global environmental Biotechnology : D.L. Wise.
12. Methods in Biotechnology: Hans Peter Schmauder
13. Introduction to Environmental Biotechnology, A.K.Chatterji, Prentice Hall of India Pvt.Ltd, New Delhi.
14. Environmental Biotechnology-Basis Concepts and Applications Indu Shekhar Thakur I.K. International Pvt.Ltd.New Delhi.
15. Environmental Biotechnology S.K. Agawal.APH Publishing Corp, New Delhi.
16. Elements of Biotechnology, by Jogdand S.N., Himalaya Publishing House, New Delhi.
17. Biotechnology,byB.D.Singh, Kalyani Publishers,New Delhi.
18. A Text Book of Biotechnogy, R.C.Dubey,S.Chand& company Ltd., New Delhi.
19. Environmental Biotechnology by S.V.S.Rana (Rastogi publication, meerut)
20. Biotechnological methods of pollution control, Abbasi, Sia and E Rameshwani

B. Sc. II Year, Semester III

EVS-312: Soil, Health and remediation measures

(TheoryPaper-VI)

Course Objectives:

a. The students are expected to gain theoretical as well as practical knowledge on different aspects of soil.

b. To assess the current status soils health.

c. Soil testing is developed to promote soil test based on nutrient management.

d. To reduce contaminants levels which are suitable for use

Unit-I **(10)**

Origin of earth, Pedagogical and edaphalogical concepts, earth crust composition, types of rocks and minerals, Components of soil, soil nutrients and its types.

Unit-II **(10)**

Factor affecting soil formation, soil forming processes, weathering of rocks, soil profile.

Composition of soil,physical, chemical and biological properties of Soil.

Unit-III: Soil: **(10)**

Importance of organic fertilizers, green manure, vermin-composting, bio-composting, Soil microbiology, Types of soil in India, Standards or soil quality required for various crops.

Unit-IV **(10)**

Soil erosion, Types of Soil erosion, Conservation of soil, Types of soil pollution, Soil pollution causes and remedies.

Unit-V: Tutorials, Seminars and Assignments **(05)**

Course Outcomes:

Students should able to:

a. Students will be able to define the basic concepts of soil and soil health.

b. Students will able to explain soil health remedies.

c. Studentswill able to explain physical, chemical and biological properties of soil.

d. Studentswill able to explainthe conservation of soil.

Reference books:

1. Soil Conservation-Norman Hudson, IInd Ed, and English language book Soc.
2. Soil and Water Conservation-Resurges, Standard Pub.And distributor.
3. Soil Pollution and Soil Organism-P.C.Mishra, Ashish Pub. Home.
4. Wealth from Waste-S.C.Bhatia (Vol.II), Atlautic Pub.
5. Environmental Chemistry-B.K.Sharma
6. Environmental Science –S.C.Santra, New central book agency.
7. A text book of Environmental studies-D.K.Asthana and Meera Asthava.
8. Ecology and Environment-P.D.Sharma, Rastogi Pub.
9. Fundamentals of Ecology-E.P.odum.
10. Environmental Science-Kannighan and Saigo, W.C.B. Pub.
11. A Text book Environmental Studies-G.R.Chatwal and Harish Sharma, Himalaya Pub.
12. Fundamental concepts in Environmental Studies.- Mishra, S.Chand Pub.
13. Environmental Studies –Erich Bharucha, UGC Pub.
14. Municipal Solid Waste management by Bandela N.N. and Tare.

B. Sc. II Year, Semester III

EVS- 321: Lab Course 3

(Practical basedonEVS -311):

1. To study the principle and applications of instruments used for microbiological study- Incubator, Inoculation chamber, Microscope.
2. To study the morphological characters of bacteria by Simple staining method
3. Study of bacteria by Grams staining method.
4. Study of bacteria by negative staining method.
5. IMVIC Test (Faecal and non faecal coliforms)
6. Qualitative analysis of water by MPN technique.
7. Identification of bacterial growth by Streak plate, Pour plate and Spread plate method.
8. Motility of bacteria by hanging drop technique.
9. Sterilization of culture media.
10. Preparation of pure culture.
11. Membrane technique (Demonstration)
12. Study of standard plate count (SPC).

B. Sc. II Year, Semester III

EVS- 322: Lab Course 4

(Practical based on EVS-312)

1. Collection and preservation of soil samples.
2. Determination of Lime by titration method.
3. Determination of organic carbon from soil samples by Ignition / Walkey method.
4. Determination of Electrical Conductivity of soil samples.
5. To study the pH of solid waste and soil.
6. Determination of NPK of Solid waste / soil samples.
7. To study the water holding capacity of soil.
8. Measurement of Noise by Noise meter (dB meter)
9. Demonstration/ Preparation of vermicompost bed for organic solid waste.
10. To study the percentage composition of degradable and non bio-degradable waste.
11. Determination of total acidity of soil sample.
12. Determination of total alkalinity of soil sample.

B.Sc. Second Year, Sem III
(Skill Enhancement Course)
EVS-313 -A : Organic Farming

Periods- 30

Course Objectives

- To Understand the Concept of Organic Farming.
- To Understand the Scope and Importance of Organic Farming.
- To Ensure Safe and Healthy Food production.

Learning Outcomes

- Helps in understanding the Role of an Organic Grower.
- Helps in understanding the Scope and Opportunities of Organic Farming.
- Can develop an organic production system

Unit 1: Fundamentals of Organic farming **Periods- 10**

Introduction to organic farming: Definition, concepts, principles and objectives, Converting soil into organic. Basic concepts of cropping pattern, cropping system and farming system. Integrated Farming System

Unit 2: Preparation and application of Organic Input: **Periods- 10**

Green manuring: Types, advantages, disadvantages, Mulching: types, advantages, Preparation of enriched compost, Preparation of vermicompost, Preparation of Panchagavya, NADEP composting, Biofertilizers: Type, application, benefits, Azolla and BGA culture and its application.

Unit 3: Organic crop management: **Periods- 10**

Nutrient management in organic production, weed management in organic production, Pest management in organic production, ITKs: Potential use in organic farming. Dos and Don'ts of Organic farming.

References:

- Principles of Organic Farming-by S.R. Reddy, *Kalyani Publishers,* New Delhi.
- Organic Farming (Theory and Practice)- by S.P Palaniappan and Annadurai, *Scientific Publishers,* New Delhi
- Reddy S R(2019) Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh
- Tolanur S (2018) Fundamentals of Soil Science IInd Edition , CBS Publishers , New Delhi
- Reddy S R (2017) Principles of Organic Farming Kalyani Publishers , New Delhi
- Dongarjal R.P. and Zade S.B(2019) Insect Ecology and Integrated Pest Management Akinik Publications , New Delhi

B.Sc. Second Year, Sem III
(Skill Enhancement Course)
EVS-313-B: Agricultural Waste Management

Periods- 30

Course Objectives

- To Understand the Concept of Agricultural waste management.
- To Understand the Scope and Importance of Agricultural waste.
- To Ensure Safe and Healthy Food production.

Learning Outcomes

- Helps in understanding the Role of Management of agricultural waste.
- Helps in understanding the Scope and Opportunities of Agricultural waste management.
- Can develop an organic production system

Unit 1: Fundamentals Of Agricultural Waste **Periods- 10**

Agricultural Waste: Definition, Types of waste- Biodegradable and Non Biodegradable. Sources of Agricultural waste, Composition of Agricultural waste.

Unit 2: Waste Management : **Periods- 10**

Biofertilizers: Defination, Types Importance of Biofertilizers, advantages, sources of Biofertilizes – Bacteria, Cyanobacteria, Production Technology. Characterization and Nutrient content, Potential use in organic farming.

Unit 3: Vermicompost : **Periods- 10**

Objectives Production, Establishment of Vermicomposting and Vermiwash unit, Storage and packaging . Characterization and Nutrient content, Potential use in organic farming.

References:

- Principles of Organic Farming-by S.R. Reddy, *Kalyani Publishers,* New Delhi.
- Organic Farming (Theory and Practice)- by S.P Palaniappan and Annadurai, *Scientific Publishers,* New Delhi
- Reddy S R(2019) Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh
- Tolanur S (2018) Fundamentals of Soil Science IInd Edition , CBS Publishers , New Delhi
- Reddy S R (2017) Principles of Organic Farming Kalyani Publishers , New Delhi
- Dongarjal R.P. and Zade S.B(2019) Insect Ecology and Integrated Pest Management Akinik Publications , New Delhi

B. Sc. II Year, Semester IV

EVS- 411: Air Pollution control technology

(Theory Paper-VII)

Course Objectives:

1: To familiarize learners with basic concepts and pollution related problems due to time varying fields.

2: To write expression for air pollution.

3: To understand physiological and psychological effects of all types of pollution.

4: To understand health impacts of different pollutions.

5: To understand kinds of environmental pollution with the help of air pollution study.

Unit-I: Introduction to air pollution: - **(10)**

Definition, Composition and Chemistry of Earth atmosphere, Sources and classifications of air pollutants: Sources of air Pollutants, Classification of air pollutants, Factors affecting air pollution.

Unit-II: Effect of air pollution: **(10)**

a) On human health, Vegetation, Historical monuments and on Materials.

b) Episodes: London smog, BhopalDisastrous, LosAngeles smog, Chernobyl disaster

Unit-III: Air sampling and analysis: **(10)**

Principle and functioning of: High Volume Air Sampler, Sedimentation, Tilak Air Sampler, Ambient air quality Monitoring:SO_x, NO_x, SPM, RSPM

Unit-IV: Pollution control methods: **(10)**

Sedimentation, Filters,Cyclone,Electrostatic Precipitator,Scrubbers.

AirPollution Act 1981, Air pollution standards – Indian ambient air quality standards and United States Standards.

Unit-V: Tutorials, Seminars and Assignments **(05)**

Course Outcomes

Students should able to:

1.To know the concept of air pollution

2. How to estimate the quality of air pollutants.

3. Able to develop the control technologies.

Reference books:

1. M.N.Rao, Air Pollution-Tata MC Graw Hill,Pub.-Comp.Wd, New Delhi
2. A.C. Stern (air Pollution)- Academic press
3. Air Pollution – V.P.Khudesia
4. Air Pollution –B.K.Sharma
5. APHA-std. methods (20th edition) APHA Pub.
6. Encyclopedia of Env. Pollution –Chatwal and others, S.Chand and comp., New Delhi.
7. Environmental Chemistry- A.K. De , Wily Eastern LTD.
8. Air Pollution control - NEERI, Nagpur
9. Pollution control in press industries S.D. Mahajan
10. Env pollution control engineering – C.S.Rao (2010) New Age International Publication.

B. Sc. II Year, Semester IV

EVS- 412: Water Management

(Theory Paper-VIII)

Course Objectives

After studying the course, learner will be able to…..

1: To understand the availability and occurrence of fresh water.

2: To understand the uses of water and problems related water resources management.

3: To introduce the various methods and techniques for application in integrated water resources.

Course Outcome

Students should able to:

1. Define Water management and its functionality along with importance.
2. Describe various types of water management aspects and their role in restoration of ecosystems.
3. To know the course occurrence, use, management and conservation of water and resources.

Unit-I: Water resources: (10)

- Global Water Balance (GWB) - Surface water sources: Lakes, Streams, Rivers

- Underground water sources: Infiltration galleries, Infiltration wells.

- Types of Lake, (Oligotrophic, Mesotrophic and Eutrophic)

Unit-II: Uses of Water and Water Supply: (10)

- Uses: Domestic, Industrial, Agricultural, Recreational, etc. - Types of Water: Fresh and Marine. Patterns of Drinking water supply

Unit-III: Restoration of Water: (10)

- Rain Water harvesting, - Roof Water harvesting, Watershed management.

Unit-IV: Management: (10)

- Self-purification of rivers, Integrated Water Resource Management (IWRM), Integrated Lake Basin Management (ILBM), Stockholm Water Prize, Water Act 1974

Case Study:

- Aurangabad Municipal Water Supply. Water Purification Treatment Plant at Pharola, Aurangabad. NathSagar reservoir (Jaikwadi dam).

Unit-V: Tutorials, Seminars and Assignments (05)

References:

1. Water and West water engineering (Vol.II) Fair / Gryger
2. West Water Engineering Metcalf and Eddy
3. Water and Waste Water Engineering-R.C.Rangwala
4. Water and Water Pollution – Handbook, vol.Eiaccio, D.L.(1977)
5. Environmental Science: S.C. Santra, (New Central Book agency Pvt.ltd.)
6. A text book of Environmental Studies: D.K.Asthana (S.Chand and Camp Ltd.)
7. A text book of Environmental science:R.N.Trivedy (Anmol Pub.Pvt.Ltd)
8. Water supply and sanitary engineering:S.C.Rangwala (CharotarPub.House Anand)
9. Environment studies:Dr.K.Mukkanti (S.Chand and camp.Ltd.)

B. Sc. II Year, Semester IV

EVS- 421: Lab Course 5

(Practical based on EVS-411)

1. Study of various equipment's used in air pollution.
2. Detection and identification of Pollen grains.
3. Dust fall measurement by sedimentation method (tiles).
4. Detection of SO_2 gas and its effect on plants.
5. Detection H_2S gas and its effect on plants.
6. Detection of NH_3 gas and its effect on plants.
7. Measurement of atmospheric temperature by maximum and minimum thermometer.
8. Preparation of PDA.
9. Detection and Identification of fungal spores/ colonies by PDA.
10. Study of various sampling techniques (Rotarod, High volume, Volumetric)
11. Demonstration of HVAS (High Volume Air Sampler).
12. Determination of SPM and RSPM by using High volume Air Sampler.

B. Sc. II Year, Semester IV

EVS-422: Lab Course 6

(Practical based on EVS-412)

1. Study of instruments used in water analysis: - pH meter, Conductivity meter, Turbidity meter, colorimeter.
2. Study of penetration of light in water reservoir by Secchi disk.
3. Determination of pH and temperature of water sample.
4. Determination for total Alkalinity of water sample.
5. Measurement of Rain-fall by Rain gauge meter.
6. Determination of residual chlorine from treated water by titration.
7. Determination of total Acidity of water sample.
8. Determination of Dissolved oxygen content from water.
9. Determination of Hardness from ground water.
10. Determination of Chlorides from water / waste water sample.
11. Study of primary productivity of water body.
12. Study of endangered species i.e. wild animals (any five).

B.Sc. Second Year, Semester IV
(Skill Enhancement Course)
EVS-413-A: Air Quality Management

Periods: 30

Course Objectives

- To analyze the Air quality.
- To make student aware about the importance of Air quality.
- To Understand the Scope and Importance of Air quality.

Unit I:Introduction-Ambient Air Pollutants Sampling, Analysis and Measurement: Sampling methods: Sedimentation, , Particulate matter sampling and analysis: Dust fall measurement, SPM and RSPM sampling using High volume air sampler; Gaseous pollutants sampling and analysis: Nitrogen dioxide, Sulphur dioxide

Unit II: Analytical Methods- Air Pollution Control: Particulate emission control: Gravity settling Chamber, Cyclone separators, Fabric filters, Electrostatic precipitators, Wet scrubbers.

Unit III:. Gaseous emission control: Principles of absorption and adsorption; Packed towers, Plate towers, Spray towers; Odour control.

Learning Outcomes

- Helps in understanding the Role of Management of Air quality.
- Helps in understanding the Scope and Opportunities in Health & Environment regarding Air quality.
- Can develop awareness in society system.

Reference:

- M.N.Rao, Air Pollution-Tata MC Graw Hill,Pub.-Comp.Wd, New Delhi
- A.C. Stern (air Pollution)- Academic press
- Air Pollution – V.P.Khudesia
- Air Pollution –B.K.Sharma
- APHA-std. methods (20th edition) APHA Pub.
- Encyclopedia of Env. Pollution –Chatwal and others, S.Chand and comp., New Delhi.
- Environmental Chemistry- A.K. De , Wily Eastern LTD.

B.Sc. Second Year, Semester IV
(Skill Enhancement Course)
EVS-413-B: Water Quality Management

Periods: 30

Course Objectives

- To analyze the water quality.
- To make student aware about the importance of water quality.
- To Understand the Scope and Importance of water quality.

Unit I:Introduction- Water quality analysis, meaning and methodology.Sampling & Preservation- Types of sample, Collection & Preservation Techniques

Unit II: Analytical Methods- Physical, chemical, biological parameters of water analysis. Water quality standards. WHO and Indian standards for potable water and raw water. Introduction to different methods of water testing methods. Titration, Colorimetric, Spectrophotometer, using soil testing kit. Internationally implemented modern methods of water management (ILBM), strategic approach towards conservation of water.

Unit III: Equipment's& Instruments- Introduction to handling of analytical instruments, demonstration, handling of glassware, laboratory safety rules etc.field visit- To sites for sample collection.

Learning Outcomes

- Helps in understanding the Role of Management of agricultural waste.
- Helps in understanding the Scope and Opportunities in Health & Agricultural
- Can develop awareness in society system

Reference:

- APHA-std. methods (20th edition) APHA Pub.
- Encyclopedia of Env. Pollution –Chatwal and others, S.Chand and comp., New Delhi.
- Environmental Chemistry- A.K. De , Wily Eastern LTD.
- Conservation of lake by Kodarkar, IAAB publication hyderabad
- Water Pollution by B.K Sharma
- Chemical and Biological Analysis of water by Trivedi and Goel

B. Sc. III Year, Semester V

EVS-511: Water Pollution

(Theory Paper-IX)

Course Objectives

Students will be able to know

After studying the course, learners will be able to....

1: To know the basic concepts of water pollution.

2: To understand the water pollution.

3: To understand effects of water pollution.

4: To understand health impacts of water pollution

Unit-I: Introduction: - **(10)**

Water pollution meaning of the terms: Portability, Sewage, effluent, sample, contamination Eutrophication, pollution, Pollutants.

Sources of water pollution: Domestic, Industrial, Agricultural.

Unit-II: Types of water pollution **(10)**

Introduction, sources and effects of pollutants on aquatic flora and fauna.

-Freshwater pollution: Rivers, Ponds and Lakes.

-round water pollution

-Marine water pollution

Unit-III: Analysis of Water: **(10)**

- **Physical Parameters:** colour, Taste, Odour, Total Solids, Suspended Solids, Dissolved Solids, Turbidity.
- **Chemical Parameters:** pH, Hardness, Chlorides, Residual chlorine, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen demand, Oil and Grease, Ammonia, Nitrates, Sulphates, Phosphates

Unit-IV: Biological Parameters: **(10)**

-Planktons, Algae, - MPN/100 ml, IMVIC Test, SPC.

Quality of Water:

-Meaning of pure water -Standards of potable water

Unit – V: Tutorials, Seminars and Assignments **(05)**

Course Outcome

Students should able to:

4. Student will able to define water pollution.
5. Discuss the causes of water pollution.
6. Explain the types of water pollution.
7. State the disease caused by polluted water.

Reference books:

1. Environmental Science; By S.C. Santra, New Central Book Agency Pvt. Ltd. New Delhi.
2. A Tex book of Environmental Studies; By D. K. Astana, S. Chand and Company ltd. New Delhi.
3. A Tex book of Environmental Science; By R.N Trivedy, Anmol Publication Pvt. Ltd.
4. Water supply and sanitary Engineering; By S. C. Rangawala, Charotar publication House Anand.
5. Environmental Studies; By Dr. k. Mukkanti, S. Chand and Company PVT. Ltd. New Delhi.

B. Sc. III Year, Semester V

EVS-512: Treatment Technology

(Theory Paper-X)

Course Objectives

Students will be able to know

After studying the course, learners will be able to…..

1: To know the basic concepts of treatment technology.

2: To understand the waste water treatment methods.

3: To understand impacts of waste water.

Unit-I: Introduction: - **(10)**

Wastewater, Definition, Types and Sources of waste water,

Need of wastewater treatment, Collection of waste water

Unit-II: Principle, working mechanism, advantages and disadvantages of following Sewage treatment methods: (10)

Preliminary Treatment:

- Grit Chamber
- Skimming Tank
- Screening

Primary Treatment:

- Sedimentation (Clarifier)
- Coagulation (Chemical Precipitation Tank)

Unit-III: Secondary Treatment (Biological Treatment): **(10)**

- Aerobic: - Trickling filter
  Activated Sludge
  Oxidation Ponds and Lagoons
- Anaerobic: - Septic Tank
  Sludge digestion and Disposal

Unit-IV: Tertiary Treatment or Chlorination **(10)**

- Aim, Need, Dose of chlorine,Ozonation,Waste Purification Method:
- Collection of raw water
- Sedimentation, Coagulation, Filtration, Disinfection
-

Unit – V: Tutorials, Seminars and Assignments **(05)**

Course Outcome

Students should able to:

a. Students will be able to define the basic concepts of waste water treatment.
b. Will able to explain sewage treatment methods.
c. Will able to explain waste purification method.

Reference Books:

1. Water And Waste Water Engineering; By R. C. Rangwala.
2. Water And Waste Water Engineering (Vol II); By Fair/Geyer/Ocun.
3. A Test Book of Sanitary Engineering; By Vinayak Gharpure.
4. Waste Water Engineering; By Metcalf and Eddy. Inc Publications.
5. Chemical And Biological Methods for Water Pollution; By R. K Trivedy. And P. K. Goyel, Enviro Publication, Post Box No. 60 Karad.
6. Methodology For Water Analysis; By M.S. Kodarkar, IAAB Publications, Hyderabad 2006.
7. Water And Waster Water Analysis; By NEERI Publications, Nagpur.

B. Sc. III Year, Semester V

EVS-521: Lab Course –7

(Practical based on EVS-511)

1. Study of sampling techniques
2. Study of preservation of water samples
3. Determination of BOD of water sample
4. Determination of COD of water sample
5. Determination of Suspended solids of water sample
6. Determination of Dissolved Solids of water sample
7. Determination of Total Solids of water sample
8. Determination of Oil and Grease in polluted water
9. Determination of free CO2 in water sample
10. Estimation of abundance of Phytoplankton's from water sample
11. Quantitative techniques in aquatic microbiology – SPC
12. The presumptive, confirmatory and completed tests for determination of sewage contamination
13. Determination of Water Quality Index (WQI)

B. Sc. III Year, Semester V

EVS- 522: Lab Course –8

(Practical based on EVS-512)

1. Estimation of Sulfate from water sample
2. Estimation of Phosphates from water sample
3. Estimation of Nitrates from water sample
4. Estimation of Nitrites from water sample
5. Estimation of Ammonia in water sample
6. Determination of Conductivity of water sample
7. Jar Test demonstration
8. Determination of Chlorine by chloroscope
9. Determination of Redox potential of water sample
10. Determination of Hydrogen Suphide in sewage sample
11. Determination of dissolved oxygen from polluted water sample by using azide modification.
12. Determination of turbidity from given water sample

B. Sc. III Year, Semester V

(Skill Enhancement Course)

EVS-513-A: Impact of Water Pollution on Ecosystems

Periods-30

Course Objectives:

1. **Understanding Water Pollution**: To provide students with a comprehensive understanding of the causes, sources, and types of water pollution, including chemical, biological, and physical contaminants.
2. **Assessing Water Quality**: To equip students with the knowledge and skills necessary to assess and monitor water quality through the measurement of key parameters such as pH, dissolved oxygen, turbidity, and pollutant levels.
3. **Analyzing Ecological Impacts**: To enable students to analyze the ecological impacts of water pollution on aquatic and terrestrial ecosystems, including effects on biodiversity, food webs, and ecosystem services.
4. **Exploring Mitigation Strategies**: To explore various strategies for mitigating and remediating water pollution, including preventive measures, such as regulatory frameworks and sustainable practices, as well as remediation techniques like wastewater treatment and habitat restoration

Unit I : Introduction to Ecosystem Responses to Water Pollution **10**

- Overview of ecosystem dynamics
- Introduction to the concept of ecological resilience
- Understanding the impacts of chemical pollutants on aquatic and terrestrial ecosystems
- Case studies on pesticide contamination and its ecological repercussions
- Exploring the effects of pollutants on biodiversity and ecosystem function
- Case studies on the impact of pollutants on keystone species and trophic interactions

Unit II: Habitat Alterations and Physical Pollution **10**

- Examining the consequences of physical pollution on aquatic and terrestrial habitats
- Case studies on habitat destruction and fragmentation due to pollution
- Understanding the role of microbial pollution in ecosystem degradation
- Case studies on the spread of waterborne diseases and their ecological implications

Unit III: Ecosystem-Based Management Strategies **10**

- Introduction to ecosystem-based approaches for pollution management and restoration
- Case studies on successful ecosystem restoration projects
- Analyzing the role of policy frameworks and governance structures in addressing water pollution

Learning Outcomes:

1. **Comprehensive Understanding**: Students will demonstrate a comprehensive understanding of the causes, sources, and types of water pollution, and its effects on ecosystems and human health.
2. **Practical Skills**: Students will develop practical skills in water quality assessment and monitoring, including the ability to measure and interpret key parameters to evaluate water quality.
3. **Critical Thinking**: Students will critically analyze the ecological impacts of water pollution, evaluating the interconnectedness of ecosystems and the implications for biodiversity and ecosystem functioning.
4. **Problem-Solving Skills**: Students will develop problem-solving skills to address water pollution challenges, proposing evidence-based solutions and management strategies to mitigate its impacts on ecosystems.

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References:

1. Reference Book: "Ecology: Concepts and Applications" by Manuel Molles and Anna Sher
2. Reference Book: "Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment" by Gary M. Rand
3. Reference Book: "Ecology" by Michael L. Cain, William D. Bowman, and Sally D. Hacker
4. Reference Book: "Principles of Conservation Biology" by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll
5. Reference Book: "Microbial Ecology: Fundamentals and Applications" by Richard L. Kirk
6. Reference Book: "Ecosystem Management: Adaptive, Community-Based Conservation" by Gary Meffe, Larry Nielsen, and Richard L. Knight
7. Reference Book: "Environmental Policy: From Theory to Practice" by Michael E. Kraft and Sheldon Kamieniecki
8. Reference Book: "Ecology: The Economy of Nature" by Robert E. Ricklefs and Rick Relyea

B. Sc. III Year, Semester V

(Skill Enhancement Course)

EVS-513-B: Water and Wastewater Treatment Processes

Periods- 30

Course Objectives:

1. **Fundamentals Understanding**: To provide a comprehensive understanding of the fundamental principles and processes involved in water and wastewater treatment.
2. **Practical Skills Development**: To equip students with practical skills in designing, operating, and maintaining water and wastewater treatment systems.
3. **Advanced Techniques**: To introduce students to advanced treatment technologies and emerging trends in the field.
4. **System Design and Operation**: To train students in the design, operation, and optimization of treatment plants.
5. **Sustainability Focus**: To emphasize the importance of sustainability, energy efficiency, and resource recovery in water and wastewater treatment processes.

Unit I : Treatment Processes: **10**

- Fundamentals of water and wastewater treatment.
- Practical skills in designing and operating treatment plants.
- Laboratory techniques for analyzing water quality.
- Hands-on training in biological, chemical, and physical treatment methods.
- Case studies and field visits to treatment facilities.

Unit II : Advanced Filtration Techniques **10**

- Overview of membrane filtration technologies (e.g., microfiltration, ultrafiltration, nanofiltration, reverse osmosis).
- Design and maintenance of filtration systems.
- Practical sessions on installation and troubleshooting of filtration equipment.
- Analytical methods for assessing filtration efficiency.
- Applications in industrial and municipal settings.

Unit III: Bioremediation and Phytoremediation **10**

- Principles of bioremediation and phytoremediation.
- Techniques for site assessment and selection of appropriate remediation methods.
- Case studies on successful bioremediation and phytoremediation projects.
- Regulatory and safety considerations in bioremediation practices.

Learning Outcomes:

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

1. **Understand Key Processes**: Demonstrate a thorough understanding of the physical, chemical, and biological processes involved in water and wastewater treatment.
2. **Analyze and Interpret Data**: Analyze water quality data and interpret the results to make informed decisions regarding treatment processes.
3. **Design Treatment Systems**: Design and evaluate the effectiveness of various water and wastewater treatment systems and technologies.
4. **Operate Treatment Equipment**: Operate and troubleshoot common equipment used in water and wastewater treatment plants.

References:

- MWH's Water Treatment: Principles and Design by John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous, 3rd Edition, Wiley, 2012.
- "Biological Wastewater Treatment, Third Edition" by C. P. Leslie Grady Jr., Glen T. Daigger, Nancy G. Love, Carlos D. M. Filipe, CRC Press, 2011.
- Metcalf & Eddy, Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton, "Wastewater Engineering: Treatment and Resource Recovery," 5th Edition, McGraw-Hill Education, 2014.

B. Sc. III Year, Semester VI

EVS-611: Environmental Toxicology

(Theory Paper-XI)

Course Objectives

Students will be able to know

After studying the course, learners will be able to…..

1: To know the basic concepts of Environmental Toxicology

2: To understand remedial measures of toxic substances

3: To understand toxicity assessment method

Unit I : Introduction **(10)**

Toxicology: Definition, Concept of Toxicology, Movement of Toxicants in the Environment, Classification of toxic substance i.e Toxic gases, Organic Poison, Inorganic Poison.

Unit II : **(10)**

a) Factors affecting Toxicity:
Chemical Factors: Polarity, Molecular weight, Nature of Chemical.
Biological Factors: Sex, Age, Body weight, Heredity and Genetic Characters.
b) Dose-response relationship
c)Acute exposure and chronic exposure

Unit III: Occurrence, Pollution sources, Uses, Effects & Remedial Measures of: (10)

a) Gases – CO, CO_2, H_2S, SO_2, NO_2
b) Heavy Metals – As, Pb, Hg, Cu

Unit IV: Environmental Toxicant – Occurrence, Sources, Their Effects and Remedial Measures of: **(10)**

a) Toxicants in water – Hydrocarbons in water,
b) Toxicants in soil – Pesticides
c) Toxicity Assessment Method, Lethal Concentration (LC), Lethal Dose (LD)

Toxicants in air – Atmospheric leadCarcinogenic, Chemistry of Carcinogenic Compounds, Carcinogens, Mutagens andTeratogens, Cancer Causing Agents- Drugs, Tobacco, Narcotics.

Unit V: Tutorials, Seminars and Assignments **(05)**

Course Outcome

Students should able to:

1. Students will know the basic concepts toxicology.
2. Will able to know the occurrence and remedial measures of toxic substances.
3. Explain the toxicity assessment method

Reference Books:

1. Environmental Toxicology; By M Satake, Y Mido, M.S Sethi.
2. Environmental Chemistry; By H. Kaur.
3. Environmental Chemistry; By A.K De.
4. Medical Jurispredence and Toxicology; By Parekh
5. Environmental Science; By Botkin and Killer
6. A Text book of Modern Toxicology, Ernest Hodgson, A JOHN WILEY & SONS, INC, Publications, New Jersey.
7. Basic Toxicology; By Frank C. Lu, Homisphere Publications Corporation, New York.

B. Sc. III Year, Semester VI

EVS-612: Industrial and laboratory safety

(Theory Paper-XII)

Course Objectives

Students will be able to know

After studying the course, learners will be able to…..

1: To know the basic concepts of Industrial Health and Safety.

2. To know the types of hazards and general safety rules

3. To know the principles of safety management.

Unit I: Introduction **(10)**

Introduction to Industrial safety, Need for integration of Environment, Health & Safety (EHS), Common safety tips – Personal protection, Lockout, Accident prevention sign, Occupational noise, Fire safety, Ladder safety.

Unit II: Industrial Safety: **(10)**

Introduction, Hazard Checklist – Housekeeping (Meaning & Methods), Machine hazards, Fire hazards, Personal Protective equipment's, Electrical equipment's, tools.

General Safety Rules.

Unit III: Safety Management **(10)**

- Safety management – Principles of safety management
- Fire preservation – Accident prevention (Principle, Basic terms)

Unit IV: Laboratory Safety **(10)**

(A)Definition, Laboratory safety methods: Personal Protective Measures like Gloves, Apron, mask, face shield, shoes etc. Handling of Chemicals, Instruments, Housekeeping. Fire Prevention, class of fires, types of fire extinguisher, different signs & symbol for chemical & instrument handling & prevention from hazard / accident.

(B) Laboratory waste management: Type of waste, storage, Handling, Disposal methods.

Characteristics of hazardous waste in laboratory: ignitability (flammable)

Reactivity, Corrosivity, Toxicity

Unit V: Tutorials, Seminars and Assignments **(05)**

Course Outcome

Students should able to:

1. Student will able to define water treatment
2. Discuss the waste water pollution.
3. Explain the types of waste water.

Reference books:

1) Industrial safety management' Hazard Identification and Risk control'

Deshmukh L. M., Tata McGraw – Hill publishing company Ltd. New Delhi.

2) Industrial safety, health and environment management system 'Jain R. K., Rao Sunil, Khanna Publishers, Delhi.

3) 'Eco-Informatics' – wealth from waste, Vol. IIIAgarwal S. K., A.P. H. Publishing corporation, New Delhi.

4) 'Fundamentals of Environmental science' Dhaliwal G.S., Sangha G.S., Ralhan P.K., Kalyani Publishers, New Delhi.

5) 'Environmental Science' Santra S.C.,New central Book Agency (P) Ltd. Kolkata.

6) Fundamentals of industrial safety and healthDr. K. U. Mistry, Siddhartha Prakashan, Janak society opp. Navrang High school, Ahmedabad -38001.

B. Sc. III Year, Semester VI

EVS- 621: Lab Course 9

(Practical based on EVS-611 & 612)

1. Estimation of Zn from provided contaminated water sample
2. Determination of iron content from contaminated water sample
3. Estimation of Pb from provided contaminated water sample
4. Estimation of Cu from provided contaminated water sample
5. Estimation of Mn from provided contaminated water sample
6. Effect of pesticides on seed germination
7. Effect of heavy metals on seed germination
8. To study the effects of gaseous pollutant SO2 on plant (Leaves and flowers)
9. To study the Accident prevention signs in Laboratory
10. To study General safety Rules for Laboratory
11. To study the Class of fire & types of extinguisher for Laboratory safety
12. Demonstration or Handling of fire extinguisher at emergency

B. Sc. III Year, Semester VI

EVS- 622: Lab Course 10

(Project work, Industrial Visit Report, Study Tour Report & Seminar)

Project work, Industrial Visit Report,& Seminar

1. **Project report**: One project: One project has to be completed during the third year as a part of practical paper of sixth semester Lab course 10. The project work is to be allotted during the fifth semester beginning along with the allotment of guide. As a part of project work, a field observation or the experimental work with specific aims and objectives can be given to the candidates. The data collection and preparation of review article on any specific topic by referring recent scientific literature can be a part of project work. The project report is to be submitted in triplicate before the semester end theory and practical examination of sixth semester. There will be 30 marks to the project out of total 50 marks.

2. **Industrial Visit Report:** At least one industrial visit is to be arranged during semester. The industrial visit report is to be submitted along with the project report.

3. **Study Tour Report**: The study tour is to be arranged for understanding the environment in total. The participation in study tour and industrial visit is compulsory. The study report is to be submitted.

4. **Seminar presentation:**

B.Sc. Third Year, SEM-VI
(Skill Enhancement Course)
EVS-613-A
ENVIRONMENTAL AUDIT

Periods- 30

Course Objectives:

1. To provide students with information in order to obtain competencies for environmental auditing.
2. To develop ability to plan, execute and document the environmental audit.
3. To develop entrepreneurial skills

Unit I Understanding Pollution: **10**

Definition; pollution, Air Pollution: Air pollutants —Sources, primary and secondary pollutants and particulate matter, HAPs (hazardous air pollutants), Indoor pollution- different sources. Water Pollution: Sources- direct and indirect, impact of pollution on water bodies groundwater pollution – sources and effects. Wastes: Source, characteristics, types, and fate of solid wastes. Metal pollution: Metals in soil, food and water, elementary idea on metal pollution. Noise Pollution: General features, sources, noise classification, effects of sound pollution. Radiation Pollution: Man-made radiation, radiation hazards, nuclear accidents. Pesticide Pollution: Definition; sources, categories, pesticides in water and effects; elementary idea on IPM. Soil Pollution: Sources, types, effects of soil pollution

Unit II Protection of Environment: **10**

International concerns and efforts for environmental protection; role of United Nations; Stockholm summit; priority issues; Rio Summit: Sustainable Development; Earth day; Environment day; ecotourism

Unit III Environmental Audit: **10**

Introduction: Definition; types of auditing, Features of Effective Auditing, Programme planning and organization of Auditing Programme, Pre visit data collection, Auditing Protocol, Onsite Audit; Data Sampling; Inspection and Evaluation and Presentation, Audit Report; Action plan, Management of Audit, Benefits of Environmental Audit, and Environmental Audit Programme in India.Practice: Any one industries case study from following:- Construction, Metal Processing, Pharmaceutical, Electrical, Electronic, Fertilizer, Pesticide, any regional Industry.

Course Outcomes:

1. Outline the basic principles of EA.
2. Understand the activities in environmental auditing.
3. Understand the importance of environmental audit.

References:

1. Humphrey N, Hadley M (2000) Environmental Auditing, Palladian Law Publishing Ltd, Cambridge, Isle of Wight.
2. Hunt D, Johnson C (1995) Environmental Management Systems, McGraw Hill, London.
3. International Chamber of Commerce (1989), Environmental Auditing, June 1989,
4. International Chamber of Commerce (1991), ICC Guide to Effective Environmental
5. Auditing. ICC Publication No 483, International Chamber of Commerce (ICC), Paris
6. Smets H (1988) The cost of accidental pollution.
7. Kovntz, H and C. Danvel (1978): Essential of management, second edition, Tata Mc Graw Hill publishing company, New Delhi.
8. Erickson, P.A. (1977) Environmental Impact Assessment – Principles and Erickson, P.A.(1977)
9. E-Resources & other digital material http://nptel.ac.in
10. Cahill, L.B (2017). Environmental Health and Safety Audits: A Compendium of Thoughts and Trends, 2 nd Edition, Bernan Press.
11. Council, N.C., Britain, G. and Unit, E.F., 2011. Handbook for Phase 1 Habitat Survey: A Technique for Environmental Audit. Nature Conservancy Council.
12. Ho G, Anda, M., Brennan, J., 2015. Water Auditing and Water Conservation. IWA Publishing • Pain, S.W., 2010. Safety, Health, and Environmental Auditing: A Practical Guide. CRC Press.
13. Thuman, A., Niehus, T., Younger, W.J., 2012. Handbook of Energy Audits, 9th ed. Routledge, Taylor and Francis
14. Van Guilder, C.V., 2014. Environmental Audits. Mercury Learning & Information

Text Books

1. Agarwal, K.M., Sikdar, P.K., Deb., S.C (2005) A Text Book of Environment, Macmillan India Limited.
2. Sharma, R.D. (1976), Organisational Management, Light and Life Publishers, New Delhi.
3. Varma and Agarwal, Theory & practice of Management Forward Book Depo, New Delhi

B.Sc. Third Year, SEM-VI
(Skill Enhancement Course)
EVS-613-B
COMPOSTING FROM SOLID WASTE

Periods- 30

Course Objectives:

1. To provide a comprehensive understanding of the principles and processes involved in waste management.
2. To equip students with practical skills in operating, and minimizing waste.
3. To introduce students to advanced technologies and emerging trends in the field.

Unit I: **10**

Definition of solid waste, sources types, solid waste collection methods. Introduction to vermiculture, definition, meaning, history, the species of earthworms; local species of earthworms, choosing right and useful earthworm, economic important, their value in maintenance of soil status.

Unit II: **10**

Sources and types of municipal solid wastes-waste generation ratesfactors affecting generation, characteristics, segregation of solid wastes – source reduction of waste – objectives of waste processing, elements of solid waste management –public role in solid waste management.

Unit III: **10**

Role of earthworms in production of organic fertilizers, what are the environmental factors requires. The matter and humus cycle (product, qualities), Ground population, transformation process in organic matter.

Learning Outcomes:

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

1. Demonstrate a thorough understanding of the physical, chemical, and biological processes involved in waste management.
2. Design and evaluate the effectiveness of various waste management systems and technologies.
3. To emphasize the importance of sustainability and recovery in waste management

Books recommended:

1. Verms &Vermitechnology by Arvind Kumar, A. P. H. Pub., New Delhi-110002.

2. Earthworms-Vermiculture &Vermicomposting by R. K. Bhatnagar & R. K. Palta, Kalyani Pub, New Delhi, Kolkata, Hyderabad.

3. A hand book of organic farming by A. K. Sharma, Agrobios (India), Jodhpur

4. A handbook of soil, fertilizer and manure by P. K. Gupta, Agrobios (India), Jodhpur

5. Organic farming in India-problems and practice by U. Thapa and P. Tripathy, Agro Pub. Academy, Udaipur.

6. Organic Farming for sustainable agriculture by A. K. Dahama, Agrobios (India), Jodhpur.