DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

FACULTY OF SCIENCE & TECHNOLOGY

2 Years P.G. Programme

Under Academic Autonomy

For University Department

Course Structure and Curriculum

As per National Education Policy 2020

Subject: Environmental Science

(Effective from 2023-24)

Two-Year Post-graduate Program

Course and Credits Distribution of Two years Master's Degree Program with Entry & Exit Option

Faculty of Science & Technology

Year / level	Sem.	Major subject		RM	OJT /FP	RP	Credits	Degree
		DSC Core Mandatory	DSE (Elective)					
First year 6.0	I	3(4) +2=14	4	4			22	**PG Diploma (after 3 years degree)**
	II	3(4) +2=14	4		4		22	
Cum. Cr. For PG Diploma		28	08	4	4		44	
Exit option with Post-graduate Diploma (44 credits) after first year or two semester with completion of courses equivalent to 44 credits								
Second Year 6.5	III	3(4)+2=14	4			4	22	PG Degree after 3 years UG or PG Degree after 4 years UG
	IV	3(4)=12	4			6	22	
Cum. Cr. For 1 year PG Degree		26	8			10	44	
Cum. Cr. For 2 years PG Degree		54	16	4	4	10	88	
2 Years -4 sem.PG Degree (88 credits) after three year UG Degree								

Note- DSC-is based on specialization

ABBREVIATION:

Major – Comprising Mandatory –is based on specialization

DSE- Discipline Specific Elective

OJT – On-the- Job Training

FP – Field Project (Corresponding to the Major (Core) Subject

RP – Research Project (Corresponding to the Major (Core) Subject

Internship/Apprenticeship - (Corresponding to the Major (Core) Subject

AS PER NEP 2020
(Under Academic Autonomy) Implemented from 2023-2024
Illustrative Credit distribution structure for Two Years Programme with Multiple Entry and Exit options –

Class: M.Sc. First Year Semester: Ist Semester
Subject: Environmental Science

Course type	Course Code	Course Name	Total Hours	Teaching Scheme week)		Credits Assigned	
				Theory	**Pr**	**Th**	**Pr**
DSC	UENV-MJ-501-T	Earth's Environment	45	Theory	-	3	-
	UENV-MJ-501-P	Lab Course- I	30	-	Practical	-	1
	UENV-MJ-502-T	Integrated Approach for Physical and Chemical Environment	45	Theory	-	3	-
	UENV-MJ-502-P	Lab Course –II	30	-	Practical	-	1
	UENV-MJ-503-T	Advances in Instrumentational Techniques	45	Theory	-	3	-
	UENV-MJ-503-P	Lab Course –III	30	-	Practical	-	1
	UENV-MJ-504-TP	Industrial Safety Measures and Health	30/45	Theory	Practical	2	-
DSE	UENV-DSE-505-TA	Wild life and Habitat Management	45	Theory	-	3	-
	UENV-DSE-505-PA	Lab Course –IV	30	-	Practical	-	1
	UENV-DSE-505-TB	Environmental Statistics and Modelling	45	Theory	-	3	-
	UENV-DSE-505-PB	Lab Course –IV	30	-	Practical	-	1
RM	UENV-RM-506-T	Research Methodology	45	Theory	-	3	-
	UENV-RM-506-P	Lab Course-V	30	-	Practical	-	1

Total Theory and Practical Credits =(3+3+3+3+3+2)+ (1+1+1+1+1) = 22

Note: Candidate has to select one theory & its related practical Elective Paper from UENV-DSE-505-TA & UENV-DSE-505-PA or UENV-DSE-505-TB & UENV-DSE-505-PB.

Class: M.Sc. First Year   Semester: IInd Semester
Subject: Environmental Science

Course type	Course Code	Course Name	Total Hours	Teaching Scheme week)		Credits Assigned	
				Theory	**Practical**	**Th**	**Pr**
DSC	UENV-MJ-551-T	Application of Environmental Biotechnology	45	Theory	-	3	-
	UENV-MJ-551-P	Lab Course- VI	30	-	Practical	-	1
	UENV-MJ-552-T	Application of Green Technology and Green Initiatives	45	Theory	-	3	-
	UENV-MJ-552-P	Lab Course –VII	30	-	Practical	-	1
	UENV-MJ-553-T	Aspects of Environmental Engineering and Technology	45	Theory	-	3	-
	UENV-MJ-553-P	Lab Course –VIII	30	-	Practical	-	1
	UENV-MJ-554-TP	CEPI and Advanced ETP Designing	30/45	Theory	Practical	2	-
DSE	UENV-DSE-555-TA	Environmental Management Systems	45	Theory	-	3	-
	UENV-DSE-555-PA	Lab Course –IX	30	-	Practical	-	1
	UENV-DSE-555-TB	Environmental Meteorology, Climate Change and Sustainability Issues	45	Theory	-	3	-
	UENV-DSE-555-PB	Lab Course –IX	30	-	Practical	-	1
OJT/ FP	UENV-OJT-556-P	Lab Course-X - On Job Training (OJT) / Field Project (FP)	120		Practical	-	4

Total Theory and Practical Credits =(3+3+3+3+2)+ (1+1+1+1+4) = 22

Note: Candidate has to select one theory & its related practical Elective Paper from UENV-DSE-555-TA & UENV-DSE-555-PA or UENV-DSE-555-TB & UENV-DSE-555-PB.

Class: M.Sc. Second Year   Semester: IIIrd Semester
Subject: Environmental Science

Course type	Course Code	Course Name	Total Hours	Teaching Scheme week)		Credits Assigned	
				Theory	**Practical**	**Th**	**Pr**
DSC	UENV-MJ-601-T	Waste Management Practices and Wealth	45	Theory	-	3	-
	UENV-MJ-601-P	Lab Course- XI	30	-	Practical	-	1
	UENV-MJ-602-T	Carbon Footprints and Sequestration	45	Theory	-	3	-
	UENV-MJ-602-P	Lab Course –XII	30	-	Practical	-	1
	UENV-MJ-603-T	Advanced Technology and CDM	45	Theory	-	3	-
	UENV-MJ-603-P	Lab Course –XIII	30	-	Practical	-	1
	UENV-MJ-604-TP	Environmental Compliances and EC Processes	30/45	Theory	Practical	2	-
DSE	UENV-DSE-605-TA	Environmental Legislation and Treaties	45	Theory	-	3	-
	UENV-DSE-605-PA	Lab Course –XIV	30	-	Practical	-	1
	UENV-DSE-605-TB	Risk Assessment and Disaster Management	45	Theory	-	3	-
	UENV-DSE-605-PB	Lab Course –XIV	30	-	Practical	-	1
RP	UENV-RP-649-P	Lab Course-XV-Research Project-I	120		Practical	-	4

Total Theory and Practical Credits =(3+3+3+3+2)+ (1+1+1+1+4) = 22

Note: Candidate has to select one theory & its related practical Elective Paper from UENV-DSE-605-TA & UENV-DSE-605-PA or UENV-DSE-605-TB & UENV-DSE-605-PB.

Class: M.Sc. Second Year   Semester: IVth Semester
Subject: Environmental Science

Course type	Course Code	Course Name	Total Hours	Teaching Scheme week)		Credits Assigned	
				Theory	**Practical**	**Th**	**Pr**
DSC	UENV-MJ-651-T	RS and GIS Application in Environmental Sustainability	45	Theory	-	3	-
	UENV-MJ-651-P	Lab Course- XVI	30	-	Practical	-	1
	UENV-MJ-652-T	EIA and Environmental Auditing	45	Theory	-	3	-
	UENV-MJ-652-P	Lab Course –XVII	30	-	Practical	-	1
	UENV-MJ-653-T	Sustainable Urban and Rural Developmental Planning	45	Theory	-	3	-
	UENV-MJ-653-P	Lab Course –XVIII	30	-	Practical	-	1
DSE	UENV-DSE-654-TA	Modern Age Energy Resources	45	Theory	-	3	-
	UENV-DSE-654-PA	Lab Course –XIX	30	-	Practical	-	1
	UENV-DSE-654-TB	Biodiversity Mapping and Protection Measures	45	Theory	-	3	-
	UENV-DSE-654-PB	Lab Course –XIX	30	-	Practical	-	1
RP	UENV-RP-699-P	Lab Course –XX Research Project-II	180		Practical	-	6

Total Theory and Practical Credits =(3+3+3+3)+ (1+1+1+1+6) = 22

Note: Candidate has to select one theory & its related practical Elective Paper from UENV-DSE-654-TA & UENV-DSE-654-PA or UENV-DSE-654-TB & UENV-DSE-654-PB.

Name of Course (Subject): **M.Sc. Environmental Science**
Under Academic Flexibility for University Department

1.   **Preamble of the Syllabus** –

As enshrined in the National Education Policy-2020 vision of introducing course curriculum for postgraduate studies under Choice Based Credit System (CBCS), the main objective of framing this curriculum of M.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 and acquire the technical skill on the Environmental Science 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

Environmental Sciences are necessarily to be taught in an inter-disciplinary curriculum. There is need to strengthen the students to understand essential aspects of environmental sciences in diverse subject areas such as chemistry, biology, pollution, geosciences, atmospheric sciences, biodiversity, natural resources management and wildlife management. There is also an additional emphasis in providing opportunities to understand the integration of modern sciences such as geographical information systems (GIS) and remote sensing applications to environmental sciences. This integration has been enabled in the syllabus.

Students would be encouraged to go beyond the classroom and conduct active action-research research projects with subject experts and institutions in different fields. Lectures and classroom sessions are accompanied by on-field visits, laboratory experiments and in-plant training. These interventions are compulsory and essential aspects of the curriculum. There are optional subject areas that can be chosen by the students as per their desire about their future professional areas. The Masters in Environmental Sciences being offered by Department of Environmental Science, under Academic Autonomy in the Dr. Babasaheb Ambedkar Marathwada University, Aurangabad would allow the student to access a broad spectrum of environmental disciplines and would naturally extend well beyond the boundaries of any single subject area.

The independent research areas and acquisition of subject-specific skills within an interdisciplinary group of subjects would help the student to proceed to conduct Ph.D.-level research in the future in Environmental Sciences. Interface with research, industry, government and society is an important convergence paradigm that would be brought about by the Masters Program. Understanding the importance of crucial wildlife management and biodiversity conservation perspectives would help protect our ecosystems and the fragile wildlife sanctuaries and national parks in Maharashtra and India.

The course of M.Sc. Environmental Science is designed as per the present needs of industrial and professional consultancy services, development of administrative, management and academic skills and at par with NET/SET syllabi. The content of syllabus is modified and reframed from time to time considering the need of time and demand from industries to incorporate recent developments and new trends in the subject. Apart from the academic curricula the students are assigned field visits, excursions, and industrial visits and special in-plant training in industries. The students are encouraged for research through the projects as a part of partial fulfilment of the M.Sc. course. The students are also given exposure to seminars, short-term trainings and guests lecture by eminent environmentalist. The course promotes the interest in the students to enrich their knowledge and involvement in the environmental protection.

Eligibility conditions:

Those who have completed B.Sc. with Environmental Science, Botany, Zoology, Physics, Chemistry, Microbiology, Biochemistry, Bio-Technology, Earth Science etc., B.E. Civil Engineering, B.Sc. Agriculture and Foreignsic Science, shall be held eligible for the admission to M.Sc. in Environmental Science.

The weightage of 1% will be given to the candidates who offered Environmental Science as one of the optional subjects at the B.Sc. level for seeking the admission to the M.Sc. Environmental Science.

Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. Admission will be done on the basis of merit in their degree score or Common Entrance Test (CET) and performance of students at their qualifying graduate level examination. The weightage of 1% will be given to the candidates who offered Environmental Science as one of the optional subjects at the B.Sc. level for seeking the admission to the M.Sc. Environmental Science.

Course structure:

The M.Sc. Course is of two years period with 88 Credits of 2200 marks. The course is divided in to four semesters, and every semester there will be 22 credits with 550 marks.

Choice Based Credit System (CBCS):

The principle of choice-based credit system has been adopted by this department. This provides flexibility to make the system more responsive to the changing needs of our students, the professionals and society. It gives greater freedom to students to determine their own pace of study and they can select one theory and its related practical paper as elective paper in each semester.

➢ **Students will have to earn 88 credits for the award of M.Sc. (Environmental Science) degree.**

Credit-to- contact hour Mapping:

One contact hour per week is assigned 01 credit for theory and 0.5 credits for laboratory courses/ research project. Thus a 03 - credit theory course corresponds to 03 contact hours per week and same analogy will be applicable for laboratory courses / research project, containing 03 contact hours per week for 01 credits practical course. Overall, one credit equal to 15 hours for theory and 30 hours for practical.

Note:

➢ **Tutorial, assignments and seminar presentation are integral components of all theory courses. Tutorials consist of conceptual / questions based on the respective theory courses in the semester covering all units of paper.**
➢ **Each theory paper of 03 credits should be taught about 45contact hours in one semester.**
➢ **Teaching duration for LAB COURSES from first to fourth semesters will be of 03 hours per week per batch per paper of 01 credit.**

Attendance:

Students must have 75 % of attendance in each course for appearing examination otherwise he / she will not be allowed for appearing the examination of each course. However, students having 65 % attendance with medical certificate may request Head of the Department for the condonation of attendance.

Pattern:

The 60:40 patterns for external and internal assessment will be implemented with continuous assessment and there shall be separate passing for external and internal assessment.

Results Grievances

Grievances related to assessment in examination will be resolved as per the provisions of university rules and regulations.

Evaluation Methods:

The assessment will be based on 60:40 ratios for external and internal pattern. In the continuous internal assessment (CIA) and semester end examination (SEE), there is separate passing.

Continuous Internal Assessment (CIA):

➢ **For the theory paper of 75 marks: The Continuous Internal Assessment (CIA) of the students, containing 20 marks for two midterm tests (10 marks per test), 10 marks for two tutorials (05 marks per tutorial), 10 marks for one seminar (08 marks for giving seminar and 02 marks for submission of hard copy of seminar) and 10 marks for attendance and overall performance of the students. The marks secured out of 50 will be scale down to 30 as internal marks secured out of 30.**
➢ **For theory paper of 50 marks: The Continuous Internal Assessment (CIA) containing 20 marks for two midterm tests (10 marks per test), 10 marks for two tutorial (05 marks per tutorial), 10 marks for one seminar (08 marks for giving seminar and 02 marks for submission of hard copy of seminar) and 10 marks for attendance and overall performance of the student. The marks secured out of 50 will be scale down to 20 as internal marks secured out of 20.**

- The first midterm exam will be taken after completion of 40 percent syllabus and second midterm exam will be taken after completion of 80 percent syllabus. The continuous internal assessment will be done by concern teachers, who is teaching that paper. The obtained score in Continuous Internal Assessment (CIA) will be considered as internal score.
- There will be 10 marks for Continuous Internal Assessment (CIA) of lab course / practical paper of 25 marks, containing 10 marks for one practical test, 10 marks for record book submission, 10 marks field work / assignments / viva on practical's and 10 marks for attendance, discipline & overall performance of student. The marks secured out of 40 will be scale down to 10 as internal marks secured out of 10.
- There will be separate passing for internal and external examination. The students have to earn minimum 40% marks for passing.

Semester End Examination (SEE):

- The semester end theory and practical examination will be conducted after completion teaching. The total marks shall be 75 for 3 credit theory courses, 50 marks for 02 credits theory course and 25 marks for 01 credits lab course / practical course. The semester end exam of 45 marks will be taken for 03 credits theory course and 30 marks for 02 credits theory course along with 15 marks lab course of 01 credits.
- Semester end examination (SEE) time table will be declared as per the university annual calendar. The paper setting and assessment of theory courses, laboratory courses and project dissertation will be done by external / internal appointed examiners.

A. Structure for theory course for Internal Assessment.

i)   Theory paper of 75 marks

Test-I	Test-II	Two Tutorials/ Assignments	One Seminar	Attendance, Discipline & Overall performance etc.	Total Marks secured out of	Marks scale down to 30 as internal score
10 Marks	10 Marks	10 Marks	10 Marks	10 Marks	50 Marks	

ii) Theory paper of 50 marks

Test-I	Test-II	Two Tutorials/ Assignments	One Seminar	Attendance, Discipline & Overall performance etc.	Total Marks secured out of	Marks scale down to 20 as internal score
10 Marks	10 Marks	10 Marks	10 Marks	10 Marks	50 Marks	

B. **Structure for lab course of 25 marks for Internal Assessment.**

Practical Test-I	Record Book	Field work / Assignments / Viva	Attendance, Discipline & Overall performance etc	Total Marks secured out of	Marks scale down to 10 as internal score
10 Marks	10 Marks	10 Marks	10 **Marks**	40 Marks	

The theory and practical examinations will be held at the end of each semester. There will be separate passing for continuous internal assessment marks and for semester end examination assed by external / internal appointed examiner center wise after getting at least minimum 40 % marks in each paper.

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(UENV-MJ-501-T :- Earth's Environment)
(Theory Course with 03 credits)
Course Objectives
Students will be able to know

1. Dynamics of human ecosystems, nature of a biotic and biotic components and balanced parameters of ecosystem.
2. The concept of our earth's environment and the presence of unique environmental conditions are responsible for presence of living creature on our planet earth.
3. The different components of human ecology and their significance can be understood very well.
4. Nature and status of the major environmental issues of human environment can understood along with different anthropogenic impacts.

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Unit-I: -   9
Earth's Environment: Earths metamorphic changes and environmental conditions, Earths uniqueness for survival and flourishing living organisms, unique physical phenomenon in earth's environment, thermal balance in earth's environment, evolution of living organisms in earth's environment, interaction of living and nonliving components in earths biosphere, balanced environmental parameters in biosphere, basic issues in environments study, importance of earth's environment study.

Unit II: -   9
Environmental Biology: the structure of Biosphere, evolution and development of living organisms diversity in biosphere, ecosystem development in biosphere, ecological processes and life support systems, impact of living organisms on nonliving environmental components, Impact of altered nonliving parameters on living organisms,

Unit-III: -   9
Human ecology: Evolution of man in biosphere, concept of human ecology, principles and scope of human ecology, components of human ecology, human ecology and human settlements, man-environmental relationships hunting gathering, fishing, mining, acquiring forestry and resources. Energy flow, food chain and food web in human modified ecosystems.

Unit-IV: 9
Anthropogenic impacts: Humans impact on the biosphere and its life support systems (including Flora, Fauna, soil, climate, atmosphere, terrestrial and aquatic ecosystems), Earth, Man and Environment - man modified ecosystem,

Unit V: 9
Issues in human environment: Human population growth, population explosion, humans' food security, human health problems, urbanization, scarcity of natural resources, carrying capacity of man in its habitat or in environment, alteration in human's environmental balance.

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Course Outcome

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Students should able to:

1. Define human ecological systems and its functionality along with stability concept of ecosystem.

2. Describes and understand the earth environments balance.

3. Recognize ecological systems role in maintaining earth's environmental balance.

4. Examine the importance of balanced environment for survival of mankind on planet earth for long time.

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3. Principles of Environmental Science — Wart K.E.F. (1973) Mc Graw Hill Book Company.
4. Basic Ecology — E.P. Odum
5. Concept of Ecology — E.J. Koromondy, 1996, concept of modern biology series, prentice Hall.
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14. Fundamental of Ecology — Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.
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, New Delhi.
17. Environment, energy, health planning for conservation — V. Vidyanath, Gyan Publishing House, New Delhi
18. Caring for the earth-A strategy for sustainable living; IUCN Publication.
19. Our planet, our health, our future: Human health and Rio Convention on biological diversity, change and desertification.
20. Report of the World Commission on Environment and Development; Our Common Future.
21. Environmental Earth Sciences Series Editor: James W. LaMoreaux.
22. Basic concepts: nature, ecology, environment.

(Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. Determination of GPP & NPP water body used for aquaculture purpose by light and dark bottle technique.

2. Identification and qualitative study of phytoplankton in water body used for fish cultivation by man.

3. Identification and qualitative study of zooplanktons in water body used for fish cultivation by man

4. Ecological study of living organisms from human habitat / man modified ecosystem, which ensures

   food security of man.

5. Quantitative analysis of planktons by Sedgwick rafter cell method.

6. Estimation of biomass from agricultural cropland / grazing grassland by harvest method.

7. Productivity study of agricultural cropland / grazing grassland by harvest method.

8. Determination of relative density of species from man modified ecosystem or from forest ecosystem by using simulation.

9. Determination of relative frequency of species from man modified ecosystem or from forest ecosystem by using simulation.

10. Determination of relative abundance of species from man modified ecosystem or from forest ecosystem by using simulation.

11. Identification pest species from man modifies ecosystem / agricultural crop.

12. Profile study of natural pond/lake and manmade reservoir.

13. To study the cover and based area study of tree species

14. To study the light intensity by sunshine record.

(UENV-MJ-502-T:- Integrated Approach for Physical and Chemical Environment)

(Theory Course with 03 credits)

Teaching Scheme **Evaluation Scheme**

Lectures	:-	3 hr/week	Continuous Internal	:-	30 Marks
			Assessment by teacher		
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

Students will be able to know

1. Understand the Integrated Approach of Physical and Chemical Environment.
2. Acquire the knowledge of Atmospheric ,hydrospheric and lithospheric chemistry
3. Identify the chemical contamination in Environment
4. Analysis process for Air, Water & Soil quality .

Unit-I: - Physical Aspects of Environmental Chemistry: **9**

Chemistry of Carbonate compounds, chemistry of hydrocarbons: introduction, types and hydrocarbons in environment, Chemistry of radionuclides - Types of radiation, Units of radioactivity, Detection and measurements of radioactivity, radioactive nucleus decay, Health threat from environmental radiation. Fission and Fusion Reactors, The future of fission based nuclear power, nuclear accidents and environmental impacts, Chemistry of hydrocarbons

Unit-II: - Chemical Agents in Environment: **9**

Introduction, definition, Scope, bio-essential metals and their role in life processes, Chemical bonding, ionization, pharmaceutical Impurities: sources, and critical principles of pharmaceutical impurities, chemistry of emerging pollutants: introduction, chemistry of industrial pollutants, Chemistry of organic and inorganic pollutants, Speciation and toxicity of heavy metals, bioaccumulation of heavy metals.

Unit III:- Atmospheric Chemistry: 9

Structure and composition of atmosphere; Primary and Secondary pollutants; Particulate Pollutants; Atmospheric aerosols; Tropospheric Chemistry – photochemical reaction; tropospheric oxidation of methane, ,; Stratospheric Chemistry– oxygen and ozone chemistry, Chemistry of urban air, Chemistry of heat trapping gases. Heat trapping gasses impact management, chemistry of acid rain, chemistry of ozone depleting gases and their reactions , impacts of CFC on stratosphere , Chemistry of photochemical smog , fog chemistry ,Chemistry of Biogases

Unit IV:- Hydrospheric chemistry :   9

Hydrochemistry of seawater and freshwater, water Sample collection guidelines, Sample preservation, Sample order, Data collection and record keeping. Characteristics of sanitary spent wash. Chemistry of cleaning agents, Soap, Detergents and bleaching agents, Chemistry of colloids, Gasoline and additives antiknock compounds, Lubricants and greases,

Unit V:- Lithospheric chemistry :   **9**

 Organic and inorganic soil components**,** Pesticides- classification, degradation, pollution due to pesticides. Organochlorine pesticides - structure and chemistry, DDT,

bioaccumulation and biomagnifications. Organophosphates and carbamate insecticides - structure and chemistry, Natural and Green insecticides -sources, target insects. Integrated Pest Management. Heavy metals -, Bioaccumulation of heavy metals. Speciation of metal pollutants - Mercury, Lead and Copper, arsenic. etc.

Course outcomes

1. Students acquire analytical skills with respect to different environmental spheres.
2. Capacity building in undertaking different on site tasks entrusted to them.
3. Advanced levels of awareness regarding environmental pollution help design pilot projects related to pollution monitoring and abatement.

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24. Emerging pollutants: origin, structure and properties- Francisco G Calvo-Flores, Joaguin Isac and Jose, Wiley VCH

(UENV-MJ-502-P :- Lab Course-II)
(Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. Studies on the concept of molarities, normality and buffer solutions.
2. Studies on Acid-base titration-principles, reaction and equilibrium.
3. Determination of organic matter by Walkley`s and Black method from soil.
4. Determination of bicarbonate and carbonate alkalinity of water.
5. Estimation of volatile solids from sewage sample by gravimetric analysis.
6. Determination of dose of chorine for disinfection of sewage.
7. Determination of alum dosage for deflouridation of water by jar test method.
8. Determination of sewage and waste strength.
9. Estimation of hydrogen sulphide from waste water.
10. Estimation of DO, BOD and COD from waste water.
11. Quantification of NPK from field soil samples.
12. Estimation of residual chlorine by chlorotex method.
13. Estimation of micronutrients of soil.
14. Determination of relative density of sewage sample.

Activities: - Industrial field visit to chemical and Pharmaceutical industries and report writing .

(UENV-MJ-503-T :- Advances in Instrumentational Techniques)

(Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

Students will be able to

1. To study the different sampling techniques, sampling equipments, sample preservation and processing of air, water and soil samples.
2. Use of instruments for environmental studies
3. To know analytical instrumentation.
4. Apply knowledge of instruments in environmental fields.

Unit-I: Sampling techniques: **9**

General consideration in sampling, Field tests, Preparation of sampling equipments, sampling preservation, objectives of sampling program, Types of sampling program, Types of error, Trouble shooting of instruments, validation and standardization of analytical instruments.

Unit-II: Chromatography: 9

Theory, Principle, Working, methods and application of Thin layer Chromatography (TLC) , Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography(GLC), Ion Exchange Chromatography, LCMS, Supercritical fluid extraction, HPTLC.

Unit-III: Spectrophotometry: **9**

Theory, Principle, working methods, application of colorimeter and spectrophotometer , ultra violet (UV) Spectrophotometer, Infra Red (IR) spectrophotometer, Nuclear Magnetic Resonance (NMR), Atomic Absorption Spectrophotometer (AAS), Flame Photometer, Fluoride Meter, Conductivity Meter, Nephlometer, turbidity Meter, pH meter , LC-MS, XRD and SEM.

Unit-IV: Air Sampling Equipments: **9**

Theory and Application of High Volume Air Sampler (HVAS), Respirable Suspended Particulate Matter (RSPM) measurements and its scope, Suspended Particulate Matter (SPM) analytical significance, its measurement and practical importance, Anderson Sampler, Tilak Air Sampler, Non dispersive infrared analyzer (NDIR), Pulsed fluorescent analyzer and chemiluminescent analyzer.

Unit-V: Microbiological Instruments and Equipments: **9**

Theory, Principle, Working and Application of Colony Counter, Autoclave, Oven, Incubator, Laminar air flow and BOD incubator.

Course Outcome

Student should be able to :

1. Describe sampling techniques, instrumental operations and trouble shooting.
2. Categorize analytical instruments used for environmental problems.
3. Illustrate application of specific analytic instrument for pollution study.

Reference Books:

1. Environmental Chemistry- G,S. Sodhi
2. Environmental Chemistry-S . E. Mannhan
3. Environmental Chemistry- A . K. De.
4. Environmental Chemistry- A Global Perspective- by G.W. Vantoon, and S J Duffiy, Oxford University Press, London.
5. Environmental Chemistry – B. K. Sharma
6. Environmental Chemistry – B. K. Sharma and Kaur
7. Environmental Pollution Analysis- S. M. Khopkar
8. Environmental Chemical Analysis- Lanin L. Marr, Malcom S.
9. Environmental Chemistry-Kannan Krishana
10. Environmental Chemistry- S.K.Banerjee
11. Environmental Chemistry- J.W. Moor and E.A. Moor
12. Destruction of Hazardous chemicals in the laboratory-G Lunn and E. B. Sanson
13. A text Book of Environmental Chemistry and Pollution Control- S.S. Dara
14. Environmental Chemistry –M Satake, Do S. Sethi, S.A. Equabal
15. Environment and Man: The Chemical Environment- J. Lenihan and W. W. Fletcher

(UENV-MJ-503-P :- Lab Course-III)

(Laboratory Course with 01 credits)

Lab Course			Evaluation Scheme		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	**Total Marks**	**:-**	**25 Marks**

1. Study on the principle, component and working operation of Flame photometer and its applications.
2. Determination of turbidity by nephlometer/ turbidity meter from water /sewage.
3. Calibration of pH and conductivity meter and their applications.
4. Studies on the principle, components and working operations of calorimeter and spectrophotometer.
5. Demonstration of HPLC for pesticide analysis.
6. Determination of dissolved oxygen content from sewage samples by using DO meter.
7. Study of color of water /sewage sample by using tintometer.
8. Determination of fluorescent compound by using photoflorometer.
9. Separation of chlorophyll pigments of green leaf by using thin layer chromatographic technique.
10. Separation of a mixture of amino acid by using paper chromatography.
11. Separation of geometric isomer compounds by using column chromatography.
12. Demonstration atomic absorption spectroscopy (AAS) for heavy metal analysis.
13. Study of Tilak Air Sampler / Anderson air sampler for bio-monitoring .
14. Validation and standardization of analytical instruments

Activities :- Field visits to various industries and research institutes to learn various instrumental techniques its operation and maintenance studies.

MSc. I st Year, Semester – I
(UENV-MJ-504-TP :- Industrial Safety Measures and Health)
(Theory Course with 02 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	2 hr/week	Continuous Internal Assessment by teacher	:-	20 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	30 Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	02	Total Marks	:-	50 Marks

Course Objectives

Student will be able to

1. Understand the challenges of safety in industrial environment and to develop the safety approaches in the people.
2. Become aware about the workers health and identify the industrial safety related legislation with respect to people involved in implementation.
3. Understand different design approaches for addressing safety and health challenges in the industrial environment.
4. Manage information system to avoid incidences.

Unit-I: Industrial Safety Measures: 10
Safety philosophy: Physical, Physiological and Psychological Factors of Safety, Safety Education and Training, Employees Participation in Safety, Safety Laws: Provisions of Factories Act and Rules, Employees State Insurance Act.
Plant and equipment safety appraisal and control techniques: Objectives. Plant safety observation. Plant safety inspections. Safety sampling. Safety surveys. Job safety analysis. Safety inventory system. Product safety. Permit to work systems. Safety tag systems. Loss control. Damage control and system safety.

Unit-II: Disaster Management in Industry: 10
Concept – Emergency preparedness at local level – Contingency Plans – Emergency planning and preparedness in international standards like ISO 14001, OHSA's 18001 and OSHA's Process Safety Management System. Safety in Chemical Industries – Introduction, different types of hazards in chemical industries and their precautions. Bulk and isolated storages, types of storages, atmospheric and pressurized storage vessels,

Unit-III: Occupational Health &Personal Protective Measures: 10
Meaning of occupational health and occupational health hazards, types of occupational health hazards in industries, physical, chemical, biological, mechanical and psychological hazards, common work related or occupational diseases, occupations involving risk of contracting these diseases, mode of causation of the diseases and its effect, diagnostic methods, methods of prevention, evaluation of injuries, medical services in an industrial establishment and its functions, occupational health service and its activity, major accident hazards control, occupational health audit and survey, occupational diseases relating to industrial work, emergency medical treatment of injuries and rehabilitation .
Personal protective equipment Introduction and requirements and assessment of PPE, type of PPE. Non respiratory personal protective devices: head protection, ear protection, face and eye protection, hand protection, feet protection, body protection. Supply, use, care and maintenance of personal protective equipment.

<u>**Course Outcome**</u>

1. Students will understand the safety and health challenges faced by the built and industrial environment, and the current approaches taken to address the same.
2. Students will become familiar with the industrial safety, legislation, and health aspects of industries and people involved in implementation.
3. Students will be able to explain the different design approaches for addressing the industrial safety and challenges in built and industrial environments.
4. Students will become aware of the different engineering and management concepts applied for addressing health and safety risks in industrial scenarios.

References:

1. Cote, Arthur, Section 1, Fire protection Handbook, 20th Edition, NFPA
2. Handbook of Industrial Safety by K.U. Mistry, Siddarth Prakashan, Gujarat
3. Industrial Accident Prevention by H.W. Heinrich, McGraw Hill Book Co.
4. Techniques of Safety Management by Dan Pederson.
5. Purandare D.D. Handbook on Industrial Fire Safety, P&A Publications
6. Industrial Safety and Environment, A.K.Gupta, Laxmi Publications, New Delhi
7. Industrial Safety: Concepts and Practices , K.T. Kulkarni, Pune Vidyarthi Griha Prakashan, 1786, Sadashiv Peth, Pune
8. Environment Management in India, R K Sapru, Ashish Publishing House, New Delhi
9. The Factories Act, 1948 & Factory Rules
10. Environment (Protection) Act, 1986 and Rules
11. Industrial Safety, Health and Environment Management Systems, R.K.Jain and Sunil S.Rao, Khanna publishers , New Delhi (2006)
12. The Maharashtra Fire Prevention and life Safety Measures Act 2006 and Rules
13. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad (1993).
14. Publications from Inter National standard organizations like ISO, OSHA, IOSH, NEBOSH etc.

(UENV-DSE-505-TA :- Wildlife and Habitat Management)
(Elective Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

Students will be able to

1. To understand the value of wildlife, its ecological importance and its scientific, commercial and ethical value.
2. Explain the threats and causes of loss of wild life and extinctions of wild species from India.
3. Illustrate different wild life conservation methods, and importance of protected areas conservations such as national parks, biosphere reserves, zoos, botanical gardens and gene banks.
4. Know the importance of wildlife management, management of forest fires, water resources, shelters and corridors management for wild life protection

Unit-I :- Introduction to wildlife and their habitat: 9

Definition and concept of wildlife, Importance of habitat of wildlife, Value of wildlife-ecological importance, Commercial value, Scientific value, Game value, Recreational value, and Ethical value, Status of wildlife-abundant, Threatened, Endangered, greatly endangered, Extinction-prone, Extinct, and vermin, Wildlife distribution in India-Himalayan Mountain system (north east and north west), Peninsular India, Tropical rainforest region of Indian, Indian desert.

Unit- II: - Threats and causes of loss of wildlife: 9

Pollution, Hunting, Superstitions, over exploitation, Developmental activities, Mining, Destruction of forest, Habitat degradation, Trade in wildlife-history of trade in wildlife, Trade in live animals, Trade in wildlife products, Wildlife trade in India, CITES.

Unit- III: - Endangered Fauna of India: 9

Causes of extinction of wild species, Endemic wild species from India, Endangered wild animals from India-Mammals, Birds, Reptiles, Amphibians.

Unit — IV: - Wildlife Conservation: 9

Need of wildlife conservation, Types conservation-In-situ conservation, Ex-situ conservation, Wildlife conservation methods, Species specific conservation methods, Crocodile breeding project, Musk deer breeding project, Project Hangul, Project elephant, project tiger etc., Community conservation methods, Protected areas such as sanctuaries, National parks, Biosphere reserves, Zoo's, Botanical gardens & gene banks.

Unit- V: - Habitat and Wildlife Management: 9

Need of wild life management, Wildlife management principles, Wildlife management techniques, Control hunting technique, Ecosystem management for wildlife, Sanctuary and national park management, Management of forest fires, Management of water resources, Shelters, Habitats, roads, Corridors management for wildlife.

Course Outcome

Students should be able to:

1. Identify the value of wildlife, its ecological importance and its scientific, commercial and ethical values.
2. Examine the threats and causes of loss of wildlife, extension of wildlife species from India.
3. Assess different wildlife conservation methods and importance of protected area such as national parks, biosphere reservoirs, zoo, botanical gardens and gene bank.
4. Evaluate importance of wildlife management, management of forest fires, water resources, shelters and corridors management for wildlife protection.

References

1. Zoos in India: legislation, policy, Guidelines and strategy, Central zoo authority, New Delhi 2007.
2. Wildlife ecology, conservation and Management , Anthony R.E.Sinclair, John M.Fryxell and Graeme   Caughly , Blackwell publishing,U.S,A. 2006.
3. Colorful Atlas on Indian wildlife Siseases and Disorders, Arora dnBipulchakraborthy B.M.IBDC, Lucknow,2008.
4. Indian wildlife yearbook ,Arora B.M., Editor., AIZ and WV .Bareilly and central zoon authority, New Delhi 2002.
5. Rehabilitation in free living wild animals, Arora.B.M. AIZ and W,V.,Bareilly., 2007.
6. Reproduction in Wild Mammalia & Conservation, Arora B.M. AIZ and WV., 2002.
7. Wild Animals in Central India, Brander,A.A. Natraj Publisher, Dehradun.
8. The Temple Tiger. Corbett,Jim., Oxford University Press, New Delhi., 2007.
9. Handbook of Environment, Forest and Wildlife Protection Laws in India., justice Kuldip Singh, Natraj Publishers, Dehradun., 1998.
10. Biodiversity conservation in managed and protected areas, katwalf Banerjee, Agrobios, India., 2002.
11. The Ecology of wildlife Diseases. Peter J.Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestribeek and Andy P. Dobson, Oxford University Press. Oxford ., 2002.
12. Text book of wildlife management, Singh, S.K, IBDC, Lucknow., 2005.

MSc. I st Year, Semester – I
(UENV-DSE-505-PA :- Lab Course-IV)
(Elective Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. Identification of wild animals by using pug marks.
2. Identification of wild species by using feeding signs and artifacts.
3. Determination of relative abundance of light attracting insects by using light trap.
4. Determination of relative abundance of creeping invertebrates by using pitfall trap.
5. Determination of birds population by using Lincoln index (Simulation)
6. Determination of total population of birds/ bats in their roost by using extrapolation method.
7. Determination of total population /density of birds from nesting ground during breeding season / or determination of total population of birds by using nests.
8. Identification of mammals from the hair morphology and histology.
9. To study the bird species by using vocal display.
10. Identification of wild species by direct observation in their habitat.
11. Determination of burrowing animal's population by using their artefacts.
12. Field visit for the study of wild species and collection of samples from various domestic and wild animals.
13. Visit to Zoo/ National Park /Sanctuary / Aquarium ect. for the study of wildlife.
14. Field visit to study the habitat components of wild species.
15. To study the natality of wild species during breeding season at zoo/aquarium / in closed ecosystem.

(UENV-DSE-505-TB :- Environmental Statistics and Modelling)
(Elective Theory Course with 03 credits)

1.

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

Students will be able to
1. Apply the fundamental concepts of statistics in environmental analysis.
2. Know the concept of probability poison and binomial distribution for the application of environmental variables.
3. Explain the concept of hypothesis, ANOVA, and regression lines to predict environmental situations.
4. Understand application of computer to interpret environmental data

Unit - I:- Fundamental Concepts of Statistics in Environment: **9**
Statistical sampling, Purpose of sampling, Principles of sampling, Merits of sampling, Basics and types of samplings, Simple random sampling, Stratified random sampling, Systematic sampling, Multistage sampling. Statistical methods for environmental systems, Primary and secondary data collection, Methods of data representation.
 Use of the statistical components for the representation of data obtained from environmental system: Measures of central tendency-mean and its types, Median, mode, Measures of dispersion-Variance, Standard Deviation, Mean Deviation, Coefficient of Variation, Range and quartile deviation, Concept and types of Skewness and Kurtosis in collected environmental data.

Unit-IL-Application of Probability in environmental data :   **9**
Basic Concept of probability - Addition and multiplication theorem of probability, Conditional probability and unconditional probability, Problems on probability depending on environmental systems data or data of environmental case studies.

Unit- 111:-Applications of test of significance in environmental data :   **9**
Hypothesis — Types of hypotheses: Null and Alternative hypothesis, Application of tests of significance in environmental systems data or in environmental case studies - t test, F test, I test , Chi-square tests, and A NOVA test, Concept of, regression analysis, -Application of regression equation in environmental data.

Unit- IV:-Computer applications in environmental science   **9**
Introduction to computer, Computer organization, Concept of software and hardware, Functions, Capabilities *and* limitations of computers, Use of computer in environmental Science, Applications of Windows XP, MS Word, MS Excel, MS Power Point, Adobe Page Maker, Adobe Photoshop in environmental science, Use of internet in environmental science, Applications of computer in environmental science.

Unit -V:-Environmental Modelling: **9**
Introduction to environment systems, concept of modelling and simulations, Types of modelling, simple regression models, Validation of models and forecasting, Population growth model, Lotka Volterra model, Gaussian plume model for dispersion of air pollutants, Box and pipe model for energy flow in ecosystem, Point source stream pollution model.

Course Outcome

Students should be able to:

1. **Apply the fundamental concepts of statistics in environmental analysis.**
   Bullet concept of probability in environmental variables.
   3. Hypotheses the problems and apply the test of significance
   4. Illustrate the environmental models for point and non-point source of pollution.

References

1. Bodkin, Daniel D. (1995). Environmental Science- Earth As a Living Planet, John Wiley & Sons, New York.
2. Clark, C.W. (1976). Mathematical Bioeconomics: Optimal Management of Renewable Resources, John
3. Gore, Anil and Paranjpe, S.A. (2000). A Course on Mathematical and Statistical Ecology, Kluwer.
4. Jorgensen, Environmental Modeling.
5. Ludwig, J.A. and Judwig, J.F. (1988). Statistical Ecology, Wiley and Sons, New York.
6. Pielou, E.C. (1997). An Introduction to Mathematical Ecology, John Wiley and Sons, New York.
7. Ray, Devraj (1998). Development Economics, Oxford University Press, Oxford.
8. Snape and Dunn, Dynamics of Environmental Bioprocesses-modeling and simulation.
9. Sen, A. (1997). Poverty and Inequality, Oxford University Press, Oxford.
10. Smith, J. M. (1982). Evolution and the Theory of Games, Cambridge University Press, Cambridge.

(UENV-DSE-505-PB :- Lab Course-IV)

(Elective Laboratory Course with 01 credits)

Lab Course   **Evaluation Scheme**

Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

4. Calculation of central tendency parameters:
   i) Mean value calculation from the primary data collected from environmental system.
   ii) Mode value calculation from the primary data collected from environmental system
   iii) Median value calculation from the primary data collected from environmental system

5. Calculation of standard deviation to the primary data collected from environmental system.

6. Calculation of Karl Person's Co-efficient of Co-relation to the data obtained from environmental study.

7. Calculation of Regression equation Y on X & X on Y from the environmental variables data and calculation of unknown value of dependent variable by using regression equation.

8. Calculation of variance from the environmental data.

9. Calculation of standard error (SE) from environmental data.

10. Problems on probability based on environmental data.

11. Application of t-test for conclusion from environmental data.

12. Application of Z test for conclusion from environmental data.

13. Application of F test for conclusion from environmental data.

14. Application of ANOVA test for conclusion from environmental data.

15. Application of chi square test for conclusion from environmental data.

16. Application of Power point presentation in environmental data presentation.

17. Use of MS-Excel in environmental data analysis.

18. Application of MS Word in environmental data presentation

(UENV-RM-506-T :- Research Methodology)

(Theory Course with 03 credits)

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

1. Student will know the different research approaches, scientific methods, criteria for good research and innovation.
2. Student will get knowledge of problems encountered while working on research plan , trouble shooting mechanism and field and laboratory problems.
3. Students will get the knowledge of data collection, presentation of data, data analysis and presentation of samples.
4. Students can collect the research data through experimentation, questioner, by direct observations and sensitivity study of spatial and temporal data.
5. Students will know importance of statically analysis , errors occurring in the collected research data and proper interpretation of produced research.
6. Students can design the research project with the help of review of produced results, techniques of interpretation, published literature and proper layout of research report.

Unit–I: **9**

Definition of research, Objectives of research, Research approaches, Significance of research, Research and scientific methods, Innovation and research, Research process, Criteria of good research, Defining the research problem, Technique involved in defining a problem, Research design, Important components and concepts related to research design, Developing a perspective research plan.

Unit-II: **9**

Problems encountered during working of research plan, Trouble shooting mechanisms for encountering, Field and laboratory problems , Data collection-by survey method and by experimentation, Types of data, Data presentation methods, Data analysis, process of data analysis, Sampling -Collection of samples, Preservation of samples (soil, water, or live specimen or live samples), Selection of representative samples, Populations and samples.

Unit-III: **9**

Tools of data collection in environmental research, Measures for maintaining accuracy in data, Sensitivity study of data, spatial and temporal environmental data., Sampling for environmental research -Probability sampling and non- probability sampling, Need of data analysis, processing and analysis of data, interpretation of data, -

Unit- IV: **9**

Interpretation of produced results, Techniques of interpretation, Conclusion of research work, reviewing of produced results/ output/data with the help of published literature, Scientific output as scientific principle or literature,

Unite V: 9

Research report writing, Steps in writing report, Layout of research report, Types of reports, research article writing, review article writing, Research proposal writing, research ethics and plagiarism in research report and in research articles.

Course Outcome

Students should able to:

1. Explain the different research approaches, scientific methods, criteria for good researches.

2. Describe the problems encountered while working on research plan, troubleshooting mechanism, field and laboratory problems.

3. Acquire knowledge of data collection, presentation of data, data analysis and presentation of samples.

4. Collect research data through experimentation, questioner y by direct observations and sensitivity study of spatial and temporal data.

5. Infer the important output from the collected research data and proper interpretation of produced research

6. Design the research project with the help of review of produced research, techniques of interpretation, published literature and proper layout of research.

References"

1. Research Methodology-Methods and Techniques, By Kothari C.R.(201 I); New Age International Publisher, New Delhi.

2. "Research methodology-Text and cases with SPSS applications" by Gupta S.L. and Hitesh Gupta (2011); International book house Pvt.Ltd, new Delhi.

3. "Stastical Methods" by S.P.Gupta, Publisher S.Chand and Sons.

4. "Fundamentals of Research methodology and stastics" by Yogesh Kumar Singh , New Age International Publication, New Delhi.

5. "How SAGE has shaped Research methods A 40 years history" by John W Cresewell, University of Nebraska. Lincoln.

6. "The Essence of Research Methodology, A Concise Guide for Master & Ph.D. students in management science, by Jan Jonker & BartjanPennink, Springer.

7. Research Methodology in Environmental Science, (Dr.Satish Patil) 2019, International Publications, Kanpur (ISBN 978-93-87556-42-3).

(Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. To study the sampling and preservation techniques in soil.

2. To study the sampling and preservation techniques in water.

3. To study the biological sampling and preservation techniques for microscopic study from water.

4. To study the biological sampling and preservation techniques for microscopic study from soil.

5. To study methods of sampling technique for hazardous substances and their sample preservation methods.

6. To determine the optimum number of samples size to represent the environmental system

7. Determination of optimum number of sample size from total population for questioner method.

8. The preparation of appropriate questioner of inventories to the societies for correct output.

9. Writing of research hypothesis and problem statement for specific topic.

10. Review writing for specific component or research topic.

11. Representation of research output in appropriate format such as picture, model, graph, bar diagram, pia chart, table etc.

12. Data interpretation with statistical tools and inferencing.

13. Use of different tools for the application of statistical tests during data interpretation.

14. The use of MS-EXCEL to interpret environmental data by determining mean. Standard deviation etc.

15. To study the Anti-Plagiarism software to compensate the errors in the research interpretation.

(UENV-MJ-551-T :- Application of Environmental Biotechnology)

(Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

Students will able to

1. Understand biotechnology.
2. Assess biotechnological tools used in pollution abatements.
3. Understand bio-safety regulations and protocol.
4. Design innovative reactor.

Unit-I: Understanding Biotechnology application and their Management: 9

Introduction, Concepts of biotechnology, Biotechnology, Bio economy and industrial ecology, Current status of biotechnology in environmental protection, application of biotechnology for industries like: Tannery, Paper, Textile, Petrochemical industries, and Hazardous waste management.

Unit-II: Biotechnology as Biosorption Technology: 9

Concept of biosorption, Advantages of biosorption process over physico-chemical methods, Use of Bacteria, fungi, and algae in biosorption, Processes using biological components for sorption, Applications

Unit-III: Novel Methods of Pollution Control by Biotechnological Ways: 9

Introduction. Vermitechnology, Waste water treatment using phytoremediation, rootzone treatment, role of mycorrhizal fungi in environmental pollution management.

Unit-IV: Pollution Abatement Control by Biotechnological Methods: 9

Biosensors for Environmental Applications, Fixed film system**,** Rotating biological contractors (RBC), Fluidised Bed Reactor (FBR), Expanded Bed Reactor (EBR), Contact Digester, Packed Bed Reactor or Packed Column Reactor (PCR), Up blow Anaerobic Sludge Blanket Reactor (UASB), Membrane Bioreactor, Modelling of Bioreactor, Innovative Reactor, Anaerobic Packed bed reactor (APBR).

Unit- V: Bio- safety: 9

Cartagena Protocol, Biosafety regulation, Scope of biosafety, Regulatory framework, Biosafety assessment and decision making, Development in trans genetic research and its applications in India

Course Outcome :

On completion of this course, students should able to :

1. Realize the activities and roles of microbes in environment and know how to se them in different applications.
2. Aware of the modern bio-technological approaches in Environmental analysis and management and need how to use this understanding in real life situations.
3. Use the regulation of bio-safety protocols for decision making development in transgenic research.

References :-

1. Microbiology-P.D. Sharma ,Rustogi publisher, meerut
2. Fundamental principle of bacteriology-P.C.Salle
3. Microbiology-Pelczar, M.S. Chand.
4. Global environmental Biotechnology : D.L. Wise.
5. Methods in Biotechnology: Hans Peter Schmauder
6. Introduction to Environmental Biotechnology, A.K.Chatterji, Prentice Hall of India Pvt.Ltd, New Delhi.
7. Environmental Biotechnology-Basis Concepts and Applications Indu Shekhar Thakur I.K. International Pvt .Ltd .New Delhi.
8. Environmental Biotechnology S.K. Agawal.APH Publishing Corp, New Delhi.
9. Elements of Biotechnology, by Jogdand S.N., Himalaya Publishing House, New Delhi.
10. Biotechnology, by B.D. Singh, Kalyani Publishers, New Delhi.
11. A Text Book of Biotechnogy, R.C. Dubey, S.Chand& company Ltd., New Delhi.
12. Environmental Biotechnology by S.V.S. Rana (Rastogi publication, Meerut)
13. Biotechnological methods of pollution control, Abbasi, Sia and E Rameshwani
14. Agarwal S. K. (1998). Environmental Biotechnology. APH Publishing Corp., New Delhi.
15. Alan Scroog (2005). Environmental Biotechnology, Oxford University Press, New York.
16. Baker K. H and D. S. Herson (1994). Bioremediation. Mc Graw Hill. Inc. New York.
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MSc Ist Year, Semester – II
(UENV-MJ-551-P :- Lab Course-VI)
(Laboratory Course with 01 credits)

Lab Course			Evaluation Scheme		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:	25
				-	Marks

1. Determination of total bacterial and fungal count from garbage piles in housing colonies..
2. Personal protection and conduct in microbiology laboratory.
3. To study the construction and working of laminar air flow bench
4. To study morphology of yeast cell by negative staining technique.
5. Developing stir tank reactor / suspension reactor for Ex-situ bioremediation.
6. Developing different types of reactor, for sewage treatment.
7. Isolation of insectivecidal microorganism
8. Developing phyto remediation system.
9. To study the growth pattern of E-coli on Macconkey's broth.
10. To study the growth pattern of salmonella on xylose-lysin-agar medium..
11. Developing vermiculture technology.
12. Encapsulation techniques.
13. Demonstration of PCR techniques.
14. Immobilization technique

Field activities:-
1. **Visit to biotechnology lab / Institute / Industries and work report.**
2. **Visit to various bioreactor and note down the performance of reactor and learn maintenance.**

(UENV-MJ-552-T :- Application of Green Technology and Green Initiatives)

(Theory Course with 03 credits)

		Teaching Scheme	Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	Total Marks	:-	75 Marks

Course Objectives

Students will be able to know

1. The concept and application of green chemistry for minimization of wastes and environmentally balanced industrial complexes.
2. To design green product to maintain quality, predictability, functionality and upgradability in order to improve performance of the products, in environment.
3. The application of green nanotechnology, carbon nanotubes, green nano particle, and biocompatibility for resource conservation, ecosystems, non-medical applications and human being.
4. The use of green chemistry in industries, fuel cell, solar energy, electric vehicles, solar photovoltaic technology and in biofuel production etc.

Unit-I :- Overview, Principle, concepts and tools of Green Technology:　　　**9**
  Overview of green chemistry, chemistry of the atmosphere, principles of sustainable and green chemistry, basic principles of green technology , concepts of atom economy and carbon trading, tools of green technology, waste minimization and climate change, zero waste technology, concept of environmentally balanced industrial complexing and industrial ecology.

Unit-II :-Green Product Design:　　　**9**
  Green product design definition, product strategy, life cycle of product, ISO 14000, environmental load of product, material selection, resources use, production requirements and planning for the final disposition (recycling, reuse or disposal) of a product, integration with existing product design approaches such as quality, producibility , and functionality, upgradability, disassembly, Greening supplier inputs, improving whole systems, international was on take-back laws, extended responsibility, eco-labeling examples from pharmaceuticals, foods, cosmetics, packaging, computers, polymer, automobiles, electronics industry.

Unit –III :- Green Nanotechnology:　　　**9**
  Introduction to Nanomaterials and green nanotechnology, fullerene, carbon nanotubes, nanoparticles, green nanoparticle production and characterization, biocompatibility, nanomedical applications of green nanotechnologies, use of nanotechnologies and materials impact on biodiversity, resources conservation, ecosystems and human.

Unit –IV :- Green technology applications :　　　**9**
  Biocatalysts, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources, solar photovoltaic technology, biofuel production (bio-ethanol and biodiesel), biomass, prevention/minimization of hazardous /toxic products, agricultural related practices and food processing, production of biodegradable materials, concept of green building, pollution free engineering process.

Unit-V: Green Initiatives:　　　**9**

Life cycle assessment of products, Material, water and energy efficiency , Waste reduction, Mission life, Green credit program, Green economy, Green jobs, New export market, Sectors of green economy, Energy economics in ecosystems, Green technology and renewable energy efficiency, Green accounting , National policy on biofuels, Sustainable green global transport, Environmental tourism, low carbon vehicles, Onboard generators and hybrid EVS, Electric public transit efficiency, Green hydrogen energy, Green living, Green choices, Zero waste creatives, Urban gardens, Recycling for sustainable future, Environmental Justice strategy, Environmental justice initiatives, Social environmental justice, Environmental human rights.

Course Outcome

Students should be able to:
1. Define the concept and application of green chemistry for minimization of wastes and environmentally balanced industrial complexes.
2. Design green product to maintain quality predictability, functionality and upgradability to improve performance of the products in environment
3. Apply the concept of green nanotechnology, carbon nano tubes, green nano particles and biocompatibility for resource conservation, ecosystems, non medical applications and human being.
4. Choose the applications of green chemistry in industries, fuel cell, solar photovoltaic technology and in bio fuel product etc.

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MSc. I st Year, Semester – II
(UENV-MJ-552-P :- Lab Course-VII)
(Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	**Total Marks**	**:-**	**25 Marks**

1. To assess the lifecycle of different industrial product **from** cradle to grave.
2. To study the recycling, reuse and disposal practices of different industrial wastes.
3. To study zero waste technology of any two industrial units.
4. To study in detail on the provisions of ISO 14000, with respect to green product design.
5. To study on ecolabelling from pharmaceuticals, foods, cosmetics, automobiles and electronic industry.
6. To assess the impact of materials on biodiversity, resources and ecosystems.
7. To study bio-fuel production methods and characterization for biodiesel and bio-ethanol.
8. To study the application of green chemistry concept in industries.
9. To study application of green chemistry concept in agricultural related practices and food processing units.
10. To study in detail the concept of green building in urban areas.
11. To study the chemical reactive involve in green nanotechnology, nano-particle production and characterization.
12. Determine the green building rating systems used around world.
13. Categorization of the different levels of green building certification.
14. Study of different types of green building materials used in India.
15. Study of green jobs and opportunities of green economy.

(UENV-MJ-553-T :- Aspects of Environmental Engineering and Technology)

(Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	**:-**	**75 Marks**

Course Objectives

1. Students will be able to identify advances waste water treatment technology for industrial and municipal waste water.
2. Student will be able to know proper industrial waste water treatment and air pollution monitoring and control for partial techniques in industry.
3. Students will be able to explains hazardous waste treatment and soil pollution control techniques for the soil pollutants.
4. Students will be able to know and plan for engineered biotechnology for the detoxification of phenols, biodegradation of pesticides and application for the treatment of spentwash , whey, high street waste etc

Unit-I :- Water and Wastewater Treatment Technologies :   **9**

Water and wastewater treatment and analysis, various steps in water treatment, Screening and types of screening , sedimentation, types and design of sedimentation tank, filtration, ultra filtration, nano filtration, disinfection, removal of iron and manganese, softening of water, taste and odour removal, removal of oil and grease, skimming Tank, function of skimming tank, disposal of skimming.

Unit-II: - Industrial Wastewater Treatment: **9**

Industrial wastewater treatment, general characters of industrial wastewater, theories of treatment, Concept of Effluent Treatment Plant (ETP), design of ETP, Concept of Common Effluent Treatment Plant, design and functioning of CETP plant for public owned treatment plant, Effluent treatment methods for pharmaceutical and automobile industry, iron and steel industry. dairy industry, pulp & paper industry, sugar industry, distillery industry, leather industry.

Unit III: Advanced Waste water Treatment Techniques :   **9**

Advanced technologies for wastewater treatment - Ozonation, Fluoridation. Reverse Osmosis, Electro Dialysis, Desalination method and Ion Exchange Methods, Advanced Oxidation Process, Thermal Evaporation, adsorption method. Membrane technology,

Unit —IV :- Industrial Hazardous Waste Treatment and Disposal Methods: **9**

Hazardous waste treatment, sources and characteristics, Hazardous waste treatment methods: Physical, Chemical and Biological treatment methods. Hazardous waste disposal methods, soil pollution, sources and monitoring, soil reclamation methods and soil pollution control. Treatment and Management: physical, chemical *and* biological treatments of Solid waste, three R"s, current management practices.

Unit —IV: - Industrial Air Pollution and control Techniques: **9**

Air pollution monitoring and control techniques, sampling and monitoring of gaseous and particulate air pollutants, ambient and stack emission monitoring, major bioreactors for waste gas purification, biofilters, biotrickling filters, and bioscrubers, prevention of indoor air pollution. Air pollution control methods for industries-application of different air pollution control technique in cement industry. Thermal power plant, Mining industry, stone crushing, asbestos industries etc. Urban Air pollution control Techniques.

Unit -V: - Environmental Engineering and Biotechnology: **9**

Environmental Engineering and biotechnology introduction, scope and application, detoxification of phenols and biodegradation of pesticides, primary and secondary sludge phenol and cyanide removal. Bioremediation for removal of industrial pollutants. Current development in the subject.

Course Outcome

Students should able to:

1. Define hazardous and non-hazardous waste treatment methods.
2. Express the air pollution control technologies for industries.
3. Use the treatment methods for hazardous and non hazardous waste management.
4. Use the advanced wastewater treatment technologies for industrial wastewater.
5. Design the biotechnology for waste management.

References

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2. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata Mcgraw-h11Pub.Co., New Delhi.
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9. Eco- Technology for pollution — Trivedi R. K. and Arvind Kumar
10. Environmental Pollution Engineering —n C. S. Rao
11. Waste Water Engineering Treatment, Disposal, Reuse — Metcalf and Eddy
12. Pandyey G. N. ad Carney G. C. 2002- Environmental Engineering, Hill Pub. New Delhi .
13. Advanced Treatment Techniques for Industrial Wastewater - Athar Hussain and Strajuddm

(Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal	:-	10 Marks
			Assessment by teacher		
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. Determination of Biological Oxygen Demand of toxic/ poisonous industrial effluent.
2. Measurement of odor of waste water sample.
3. Determination of Chemical Oxygen Demand in Industrial waste water
4. Determination of oil and grease in waste water.
5. Determination of H_2S in waste water.
6. Characterization of solid waste.
7. Determination of water insoluble matter in non-ferric alum
8. Determination of moisture content and pH of prepared activated carbon.
9. Determination of available chlorine in bleaching powder.
10. Determination of sodium hydroxide content from caustic soda.
11. Determination of effective size and coefficient of uniformity of filter sand
12. Determination of moisture content and percentage of calcium in lime.
13. Problems on calculation of capacity of aeration tank in activated sludge process.
14. To study the design , working and problems of primary clarifier, trickling filter and septic tank.
15. Determine of MLSS, MLVSS, & SVI of industrial waste water.

(UENV-MJ-554-TP :- CEPI and Advanced ETP Designing)
(Theory Core Course with 02 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	2 hr/week	Continuous Internal Assessment by teacher	:-	20 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	30 Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	02	Total Marks	:-	50 Marks

Course Objectives
Student should be able to:
1. Industrial waste water treatment and its planning for effluent treatment plant.
2. The physical , chemical and biological unit processes, its operation and control.
3. Primary, secondary and tertiary waste water treatment system.
4. The use of advanced waste water treatments such as –Ion exchange, electrodialysis, advanced oxidation processes, fenton based AOPs and emerging technologies for treatment of waste water.
5. The mechanism for environmental management of critically polluted areas and consideration areas of industrial cluster.

Unit I :–   **10**

Effluent treatment plant; Use of water in industries, Industrial waste water sources, National standards for waste water, Waste water treatment, Planning an effluent treatment plant.

Treatment Methods:- Physical, Chemical and biological unit processes; Operation and control; MLSS, SVILDI, Mean Cell residence time (MCRT), Food/Mass ratio, Constant MLSS, Return Activated Sludge Control (RASC).

Unit II: –   **10**

 Choosing an effluent plant, Physio-chemical and biological waste water treatment, Aerobic and anaerobic processes for waste water treatment; Sludge management, Cost comparison, Tertiary waste water treatment systems; Pressure filters, Ion exchange, Electrodialysis, Solar still, Membrane filtration, Advanced oxidation processes, Fenton based AOPS, Emerging AOPS, Disinfection of waste water, Emerging technologies for treatment of waste water, Life cycle costing of ETP.

Unit III: – Comprehensive Environmental Pollution Index (CEPI):   10

Mechanism for environmental management of critically and severely polluted and consideration areas, Environment quality management date; Assessment criteria of CEPI; Comprehensive environment assessment of Industrial Cluster, Methodology and monitoring protocols for CEPI in critically polluted areas, Air and water quality management; Quality assurance controls; Waste management; Contaminated site of industrial pollution, Noise Pollution, Urban pollution, Pollution control planning, Use of Information Technology in Environmental training, infrastructure development and capacity building.

Course outcome:

Students should be able to:

1. Define the National Standards for waste water and industrial waste water sources.
2. Use the effluent treatment plant effectively for physico-chemical and biological waste water treatment.
3. Know the sludge management, aerobic and anaerobic processes for waste water treatment and the cost comparison of the different treatment processes.
4. Design the emerging technologies for treatment of waste water and life cycle costing of ETP.
5. Express the mechanism of protocols for CEPI in critically polluted areas, air and water quality management and its quality assurance.

References.

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M.Sc. Ist Year, Semester – II
(UENV-DSE-555-TA :- Environmental Management Systems)
(Elective Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	Total Marks	:-	75 Marks

Course Objectives

1. Students will be able to understand the concept of Environmental Management System with International and National standards.
2. Students will be able to plan for environmental planning for air, water, soil, natural heritages, Demography and Natural Assets.
3. Students will be able to indentify micro and macro planning for natural resources at national and regional level rural and urban areas.
4. Students will be able to know the concept of LCA, functions of environment and enterprises, concept and applications of ISO 14000 and OSHAS 18000 for ecolabeling.
5. Students will be able to plan for total quality management and business environment, fair environmental practice and international environmental initiatives.

Unit –I: Environmental Management: 9
Environment Management system - Principle and elements, Concept and Scope, Systems and approach, Standards- International and National; Eco-mark, Environmental accounts and auditing, Green funding and taxes, Trade and Environmental Management.

Unit-II: Environmental Planning: **9**
Historical Background to know the adverse effects of lack of environmental planning, Importance and Measurement of baseline environmental data and their appraisal such as Water, Soil, Air, Natural assets, Demography, Heritage.

Unit-III: Environmental planning, Micro & Macro planning, rural & urban planning: 9
Concept and need for environmental planning, Levels of planning-Micro & Macro Planning, National and regional Planning, Basic difference in rural and urban planning, Demographic consideration, Dynamic, Available resource planning, Gandhian concept of self-relined Villages.

Unit- IV : Environment Management plan and ISO:14000 series: **9**
Scope of environmental management, Importance, Principle functions of environment and enterprise, Objectives and need for training staff, Criteria for environment instruments, Project management, Production Management, Back ground and development of ISO 14000, OSHAS 18000.
Life Cycle Assessment: introduction about LCA, Characteristics of LCA, History of LCA, Application of LCA, ISO 14000 series/protocols for LCA, Procedure of LCA, Case studies of LCA-PVC industry, Steel industry, Pulp and paper industry.

Unit- V : Sustainability issues in India:
Climate change, Natural resource use, Water production, Water pollution, Deforestation, Overfishing, Ocean acidification, air pollution, Water scarcity, Sustainable food production and demand, decreasing biodiversity, loss of resilience in ecosystem, lack of waste management, depletion of resources (land, air, water), Non- conventional energy resources, . Industrial sustainability: Challenges, Perspectives, actions. The transformation path of leading companies, Action towards industrial sustainability; A industrial sustainable approach; Measuring Industrial Sustainability; Effective Climate action, Waste Management, Green Competitiveness, Building Climate Resilient Industry, Challenges for business in implementing the biodiversity act.

Students should be able to:

1. Illustrate the concept of environmental management system the national and international standards.
2. Asses the plan for environmental planning for air, water, soil, heritage, demography and natural assets.
3. Identify micro and macro- planning for natural resource at national, regional, rural and urban areas.

   Define the concept of LCA, environmental enterprises, ISO 14000 and OSHAS 18000, total quality management and business environment, fair environmental practices and international environmental initiatives.

References

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3. T V Ramchandra, "Management of Municipal Solid Waste" Capital Publishing.
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6. Environmental management: H.M.Saxena: Rawat Publications.
7. Environmental Law and Policy in India: S.Divan & A.Rosencranz; oxford University Press.
8. Environmental management-Physio-ecological facets (Vol.I & II): Rai, Mohapatra & Goel (ed) Rawat Publications.
9. Environmental Management in India Vol.I & II: R.K. Sapru; Ashish Publishing House.
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Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

2. Study on International and National standard of Air, Water and Soil

3. Study in detail on Environmental accounts and auditing, green funding and taxes trade and environmental management in any two industrial units.

4. To evaluate the adverse   effect of lack of environmental planning in industries (Any two)

5. To prepare base line data on water, soil, air, natural assets, demography, and heritage of any two project areas.

6. Study of rural and urban environmental planning at regional level.

7. Study on resource planning at regional and national level.

8. Study on Gandhian concept of self-relied villages.

9. Study of ISO: 14000 and OSHAS 18000

10.   Studies on LCA of pulp and paper industry, food industry and crop plants.

10 To study the Ramsar Convention on wetlands with few case studies.

11 To study the application of Vienna Convention Montreal protocol and Kyoto protocol in India.

12 To study trade and commerce practice and fair environmental practice at national and international level.

 Activities: - Field visit to various industries, major project areas and National management Institutes to study in   detail on Environmental management systems

M.Sc. I st Year, Semester – II
(UENV-DSE-555-TB :- Environmental Meteorology, Climate Change and Sustainability Issues)

(Elective Theory Course with 03 credits)

Teaching Scheme			Evaluation Scheme		
Lectures	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	30 Marks
Tutorials	:-	2 per/ semester	Sem-End Examination	:-	45Marks
Internal Test	:-	2 Tests /semester			
Seminar	:-	1 Seminar / semester			
Total Credit	:-	03	**Total Marks**	:-	**75 Marks**

Course Objectives

Students will be able to

1. Know different climatic regions of the world, distribution of vegetation and condition of climate in India.
2. Know the various seasons in India distribution of rainfall, forecast of monsoon and climatic considerations in Agriculture and Industrial sector.
3. Identify meteorological parameters to forecast the weather, scale of meteorology and to establish ambient and emission standards.
4. To assess different earths process, natural cycles and risk of geological hazards, like earth quake, floods, landslides, volcanism etc

Unit — I :- Climatology: 9

Introduction of climatology, fundamental principles of climatology, the climate system, controls on climate, Global Climate classification, major climatic regions of the world based on latitude and distribution of vegetation, earth-sun relation, coastal effect on climate, orographic effect on climate, different climate zone, trends of climate and its variability, climate modification. Inter annual variability of climate and its effect on biosphere, different climate methods, Regional distribution and seasonal variation of cloud, precipitations and fog etc.

Unit— II :- Applied Climatology :   9

Climate and water resources, climate and agriculture, climate change and ecosystem, climate change **and** food security, climate change and green house gases, Effect of change on ecology, biodiversity reproduction, species etc, climate change and disease, climate change and global catastrophic risk, climate change and diseases.

Unit-III: - Climate of India: 9

Weather, Climate, Physiographic and geological homogeneity of India, Geo-economic significance, Classification of climates, Criteria for classification, Thornthwaites and Koppens classification, Climates of India, Indian monsoon, Jet streams general circulation, The seasons mechanism of monsoon, Forecast of monsoon various seasons, Distribution of rainfall, Drought prone areas, Flood prone areas, Climate change, Causes and consequences of global warming, Ozone hole , Sea level rise in climate, Climatic considerations in industrial locations, (EI-Nino, droughts, tropical cyclones and western disturbances, IPCC, UNFCC, Kyoto protocol)

Unit— IV :- Meteorology: 9

Scale of meteorology, Meteorological fundamentals, Primary and secondary meteorological parameters, Temperature, Pressure, wind, Humidity, Adiabatic lapse rate, Miringhighs , Wind velocity, Wind roses, Turbulence, Plume behavior, Weather forecasting, Establishing ambient and emission standards, Application of meteorological principles to transport and diffusion of pollutants.

Unit — V :- Earths Processes and Geological hazards :   9

Earths processes, Concept to residence time and rates of natural cycles, Catastrophic geological hazards, Study of earthquakes, Volcanism, floods, Landslides, Avalanche etc.

prediction and perception of hazards, Adjustment to hazardous activities, Assessment of geological hazards and risks.

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19. Geo Environmental Engineering :Reddic, Tecnip books international, New Delhi.
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21. Physical Climatology-William D.Sellers.
22. Clirnatology-Bernhard-Haurwitz and J.M. Austin.
23. Dynamical and Physical Meteorology-George J. Haltiner and F.L. Martin
24. Physics of Monsoon-Keshav Murthy and Sankar Rao.
25. Essentials of meteorology-C.Donald Ahrens.
26. Foundation of Climatology-E.T.Stinger.
27. Climate Change : Emerging Scenarios and adaptation strategics :Vol 1 (2020) : Satish S. Patil, nternational Publication. Kanpur, (ISBN 978-93-87556-88-1)
28. Climate Change : Emerging Scenarios and adaptation strategies Vol:II (2020) : Satish S. Patil, International Publication. Kanpur, (ISBN 978-93-87556-88-1)
29. An Introduction to Climate-G.W.Threwartha.
30. The Nature and Causes of Climate Change-Goodies, Paultskaf and Davies.

(Elective Laboratory Course with 01 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	3 hr/week	Continuous Internal Assessment by teacher	:-	10 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	15Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Record / semester			
Total Credit	:-	01	Total Marks	:-	25 Marks

1. Collection techniques and sampling devices for gaseous pollutants
   i)Absorption sampling, ii) Adsorption sampling, iii) Freeze out or condensation sampling, iv) Grab sampling.
2. Study of micrometeorological equipments.
3. Determination of relative humidity of air .
4. Determination of atmospheric pressure by using Barometer.
5. Determination of wind speed by using Anemometer.
6. Determination of wind direction by using wind vane.
7. Interpretation of wind rose diagram.
8. Determination of Air pollution index.
9. Determination of NO_x in ambient air by high volume sampler (HVS).
10. Measurement of SO_X by high volume sampler (HVS).
11. Measurement of SPM by using high volume sampler (HVS).
12. Measurement of RSPM by using Respirable Dust Sampler.
13. Identification of minerals on the basis of physical properties
    (10 minerals   specimens).
14. Identification of rocks: Igneous rock, sedimentary rock and metamorphic rocks.

M.Sc. Ist Year, Semester – II
(UENV-OJT-556-P :- Lab Course-X – On Job Training(OJT) / Field Project(FP))
(Laboratory Course with 04 credits)

Lab Course			**Evaluation Scheme**		
Practical	:-	12hr/week	Continuous Internal Assessment by teacher	:-	40 Marks
Internal Test	:-	1 Tests /semester	Sem-End Examination	:-	60 Marks
Internal Viva		1 time during internal test			
Record submission	:-	1 Report / semester			
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

The student has to undergo 4 (four) weeks industrial internship [On Job Training (OJT)] at the end of II nd semester. The candidate has to produce the certified (OJT) report strictly within a week after the completion of the said training with the structured evaluation pattern. The deputation of the students in industry will be done either by Placement cell of university or by Department.