DR. BABASABEB AMBEDKAR MARATHWADA UNIVERSITY
AURANGABAD- 431004 (M.S)

Department of Environmental Science

Structure and Curriculum

For

M.Sc. Environmental Science Programme

(Choice Based Credit System)

Academic Autonomy

(Effective from June 2015 onwards)

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Course Structure

M.Sc. (Environmental Science) in Choice Based Credit System

From Academic Year 2015-2016

110 credits against 2650 marks.

	M.Sc. I year (Semester- I)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
COM	COM-100	Constitution of India	02	02	50
RM	ENV-001	Research Methodology Part-I	02	02	50
FC	ENV-401	Foundation Course on Environment	04	04	100
CC	ENV-402	Environmental Chemistry	04	04	100
CC	ENV-403	Environmental Instrumentation & Analysis	04	04	100
EC	ENV-421A	Wildlife Conservation & Management	04	04	100
EC	ENV-421B	Environmental Metrology & Geosciences	04	04	100
LC	ENV-441	Lab Course-I	04	02	50
LC	ENV-442	Lab Course-II	04	02	50
LC	ENV-443	Lab Course-III	04	02	50
LEC	ENV-444A	Lab Course-IV	04	02	50
LEC	ENV-444B	Lab Course-IV	04	02	50
Total Credits for Semester – I : 28 (Theory:20 ;Lab:08) (With One Elective Course)					
	M.Sc. I Year (Semester-II)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
RM	ENV-002	Research Methodology Part-II	02	02	50
CC	ENV-404	Environmental Biotechnology	04	04	100
CC	ENV-405	Green Technology	04	04	100
CC	ENV-406	Environmental Engineering & Technology	04	04	100
EC	ENV-422A	Environmental Management Systems	04	04	100
EC	ENV-422B	Environmental Statistics & Modeling	04	04	100
LC	ENV-445	Lab Course-V	04	02	50
LC	ENV-446	Lab Course-VI	04	02	50
LC	ENV-447	Lab Course-VII	04	02	50
LEC	ENV-448A	Lab Course -VIII	04	02	50
LEC	ENV-448B	Lab Course-VIII	04	02	50
Total Credits for Semester – II : 26 (Theory:18 ;Lab:08) (With One Elective Course)					
	M.Sc. II year (Semester- III)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
CC	ENV-501	Municipal & Hazardous waste Management	04	04	100

CC	ENV-502	Remote Sensing and GIS application for Environmental Management	04	04	100
CC	ENV-503	Environmental Toxicology & Biodiversity Assessment	04	04	100
EC	ENV-521A	Environmental Plan, Policies, and legislation	04	04	100
EC	ENV-521B	Ecological footprints and carbon sequestration	04	04	100
SC	ENV-522	Climate Change and Global Environmental Issues	04	04	100
LC	ENV-541	Lab Course- IX	04	02	50
LC	ENV-542	Lab Course- X	04	02	50
LC	ENV-543	Lab Course- XI (Project /Dissertation Part- I)	08	08	100
Total Credits for Semester – III : 32 (Theory:20 ;Lab:04;Research Project :08) (With One Elective Course)					
	M.Sc. II Year (Semester-IV)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
CC	ENV-504	Risk Assessment and Disaster Management	04	04	100
CC	ENV-505	EIA & Environmental Auditing	04	04	100
EC	ENV-523A	Advanced Technologies & CDM	04	04	100
EC	ENV-523B	Ground Water Engineering and Watershed Management	04	04	100
LC	ENV-545	Lab Course-XII	04	02	50
LC	ENV-546	Lab Course – XIII (Field work and In-plant training)	04	02	50
LC	ENV-547	Lab Course- XIV (Seminar / Dissertation Part- II)	08	08	200
Total Credits for Semester – IV : 24 (Theory:12 ;Lab:04;Research Project :08) (With One Elective Course)					
Total Credits : 110 (Sem I : 28 +Sem II : 26 + Sem III : 32 + Sem IV:24)					

COM: Common, **RM: Research Methodology**
CC: Core Course **EC: Elective Course**
LC: Lab Course **LEC: Lab Elective Course**
SC: Service Course **FC: Foundation Course**

Introduction :

The Department of Environmental Science was established in June 1985. The department offers M.Sc. and Ph.D. degrees in Environmental Science as a commitment to higher education to rural youth. The department has produced more than 450 post graduate students and more than 60 Ph.D. students so far. The major domains of research activities are in the areas of Environmental monitoring, Environmental Managements, Water Pollution, Waste Water Treatment, Solid and hazardous waste management, under water quality testing, LCA, EIA, Wild life,

Energy Studies, hydrobiology and limnology, Toxicology, RS, GIS and its applications, Disaster Management, Ecology, Environmental Biotechnology, Environmental Microbiology .

The alumni of this department are presently working in various fields like education, industry, Banks, Agriculture, Medical, Central and State and Central Government services. Most of the alumni are working as key person in Education fields, Maharashtra Pollution Control board, industries and in the field of Environmental consultancies in Maharashtra and India. The employment percentage of the students is about 98%. The students from foreign countries also get admitted to M.Sc. as well as Ph.D. courses since last 20 years.

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 after every 2-3 years 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 trips, 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 fulfillment of the M.Sc. course. The students are also given exposure to seminars, short-term trainings and guests lecture by eminent environmentalist. The faculty promotes the interest of the students to enrich their knowledge and involvement in the subject.

The Department has adequate infrastructure and research laboratories and well equipped instrumentation laboratory with sophisticated equipments and computer lab with computers with GIS Software. The students are provided internet access. Almost all the essential books and literature as per the syllabus are available in the central library. The department is also providing a consultancy services to the industry/institution and peoples. The intake capacity is 32 for M.Sc. and for the Ph.D. it is 32. Now the department is implemented Choice Based Credit System and CGPA and AGP system for the gradation of the students. The Department has developed a Parmaculture Garden with a concept of Ecologically Engineered Design to develop a habitat of birds, creepers, butterflies and honey bees to maintain the balance in the existing ecosystem.

Eligibility conditions:

Those who have completed B.Sc. with Environmental Science, Botany, Zoology, Physics, Chemistry, Microbiology, Biochemistry, Bio-Technology, Earth Science etc., B.E.(Bachelor of Engineering) and B.Sc. Agriculture subjects 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 subject 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 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 subject at the B.Sc. level for seeking the admission to the M.Sc. Environmental Science Once the student is admitted he / she will be promoted to the 2^{nd} year (3^{rd} semester) if he / she qualify all courses 1^{st} semester and 50 % of theory courses of 2^{nd} semester. Students will have to register themselves for every consecutive semester. Dropout students will be allowed to register for respective semester as and when the concerned courses are offered by the department, however he / she should not exceed more than twice the duration of the course from the date of first registration at parent department. The admission of the concern student will be automatically cancelled if he / she fails to complete the M. Sc. degree within a period of maximum four years / eight semesters.

Course structure:

The M.Sc. Course is of two years period with 110 Credits of 2650 marks. The course is divided in to four semesters. In first semester there will be 28 credits with 700 marks. Second semester is of 26 credits with 650 marks, Third semester is of 32 credits with 700 marks and fourth semester is of 24 credits with 600 marks. Paper No ENV-

522 of 4 Credits of 100 marks from III[rd] semester will be a **Service Course** which needs to opt by the students from the other departments.

During the two years study course students has to earn the total credits from the following manner.

1.	**Core Courses**	**:- 40 credits**
2.	**Elective Courses**	**:- 16 credits**
3.	**Foundation Course**	**:- 04 credits**
4.	**Service Course**	**:- 04 credits**
5.	**Lab Courses**	**:- 40 credits**
6.	**RM Courses**	**:- 04 credits**
7.	**COM Course**	**:- 02 credits**
	Total Credits	**:- 110 credits**

Above credits includes the credits for Research Methodology /Project /Seminars etc. in the following manner ,04 credits-RMC and 18 credits for Project / Seminars /In-plant training etc, with a total of 22 credits for research project assignment

Courses:

1. **Core Course (C.C) :** Core course is a course that a student admitted to a particular P.G. Program must successfully complete to receive the degree. Normally no theory course shall have more than four credits.
2. **Elective Course (E.C) :** Elective course means an optional course from the basic subject or specialization.
3. **Foundation Course (F.C):** It includes fundamentals of environment, necessary to the students offering the course from other disciplines.
4. **Service Course (S.C):** Service course will be offered in IIIrd semester. Students must complete a service course for securing M.Sc degree to acquire 4 credits.
5. **Lab Course (L.C) :** It includes all laboratory assignments related to theory courses.
6. **Research Methodology (R.M):** This course includes research related components to understand basics in the research and develop the research skill.
7. **Common Course (COM) :** This course is introduced to learn the Great Constitution of India.

- Each course shall include lectures/ tutorials/laboratory or field work/seminar/practical training/assignments /mid-term and term end examination/paper/report writing or review of literature and any other innovative practices to meet effective teaching and learning needs.
- The student will have to register the service course of his interest after the start of semester in the concerned department on official registration form. The teacher in charge of the respective course will be given from the date of admission for completion of registration procedure. The Departmental Committee will follow a selection procedure after counseling to the students etc. to avoid overcrowding to particular course(s) at the expense of some other course.
- The department will decide the maximum number of students in each service course taking into account the teachers and Physical facilities available in the Department.
- No service course will be offered unless a minimum of 10 students are registered.

Choice Based Credit System (CBCS) :

The 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. The credit based system also facilitates the transfer of credits.

- Students will have to earn 110 credits for the award of M.Sc. (Environmental Science) degree.
- Out of 110 credits, students will have to earn 104 credits from Core courses worth 40 credits, foundation course worth 04 credits, elective courses worth 16 credits, laboratory courses worth 22 credits research project of 22 credits (distributed in all semesters) from Environmental Science Department , 04 credits of open elective (Service course) from any department in the university campus and 02 credits from the course 'Constitution of India'.

Credit-to- contact hour Mapping:

One contact hour per week is assigned 1 credit for theory and 0.5 credits for laboratory courses/ research project. Thus a 4 - credit theory course corresponds to 4 contact hours per week and same analogy will be applicable for laboratory courses / research project.

Course Structure
(110 Credit against 2650 marks)

	M.Sc. I year (Semester- I)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
COM	COM-100	Constitution of India	02	02	50
RM	ENV-001	Research Methodology Part-I	02	02	50
FC	ENV-401	Foundation Course on Environment	04	04	100
CC	ENV-402	Environmental Chemistry	04	04	100
CC	ENV-403	Environmental Instrumentation & Analysis	04	04	100
EC	ENV-421A	Wildlife Conservation & Management	04	04	100
EC	ENV-421B	Environmental Metrology & Geosciences	04	04	100
LC	ENV-441	Lab Course-I	04	02	50
LC	ENV-442	Lab Course-II	04	02	50
LC	ENV-443	Lab Course-III	04	02	50
LEC	ENV-444A	Lab Course-IV	04	02	50
LEC	ENV-444B	Lab Course-IV	04	02	50
Total Credits for Semester – I : 28 (Theory:20 ;Lab:08)					
	M.Sc. I Year (Semester-II)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
RM	ENV-002	Research Methodology Part-II	02	02	50
CC	ENV-404	Environmental Biotechnology	04	04	100
CC	ENV-405	Green Technology	04	04	100
CC	ENV-406	Environmental Engineering & Technology	04	04	100
EC	ENV-422A	Environmental Management Systems	04	04	100
EC	ENV-422B	Environmental Statistics & Modeling	04	04	100
LC	ENV-445	Lab Course-V	04	02	50
LC	ENV-446	Lab Course-VI	04	02	50
LC	ENV-447	Lab Course-VII	04	02	50
LEC	ENV-448A	Lab Course -VIII	04	02	50
LEC	ENV-448B	Lab Course-VIII	04	02	50
Total Credits for Semester – II : 26 (Theory:18 ;Lab:08)					

	M.Sc. II year (Semester- III)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
CC	ENV-501	Municipal & Hazardous waste Management	04	04	100
CC	ENV-502	Remote Sensing and GIS application for Environmental Management	04	04	100
CC	ENV-503	Environmental Toxicology & Biodiversity Assessment	04	04	100
EC	ENV-521A	Environmental Plan, Policies, and legislation	04	04	100
EC	ENV-521B	Ecological footprints and carbon sequestration	04	04	100
SC	ENV-522	Climate Change and Global Environmental Issues	04	04	100
LC	ENV-541	Lab Course- IX	04	02	50
LC	ENV-542	Lab Course- X	04	02	50

LC	ENV-543	Lab Course- XI (Project /Dissertation Part- I)	08	08	100
Total Credits for Semester – III : 32 (Theory:20 ;Lab:04;Research Project :08)					
	M.Sc. II Year (Semester-IV)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
CC	ENV-504	Risk Assessment and Disaster Management	04	04	100
CC	ENV-505	EIA & Environmental Auditing	04	04	100
EC	ENV-523A	Advanced Technologies & CDM	04	04	100
EC	ENV-523B	Ground Water Engineering and Watershed Management	04	04	100
LC	ENV-545	Lab Course-XII	04	02	50
LC	ENV-546	Lab Course – XIII (Field work and In-plant training)	04	02	50
LC	ENV-547	Lab Course- XIV (Seminar / Dissertation Part- II)	08	08	200
Total Credits for Semester – IV : 24 (Theory:12 ;Lab:04;Research Project :08)					
Total Credits : 110 (Sem I : 28 +Sem II : 26 + Sem III : 32 + Sem IV:24)					

Notes:

- Tutorial, assignments and seminar presentation are integral components of all theory courses. Tutorials consists of conceptual / questions based on the respective theory courses in the semester covering all five (05) units.
- Each course / paper should be taught for 40 to 45 contact hours.
- Teaching duration for LAB COURSES from first to fourth semesters should be of 04 hours per week per batch.
- Teaching duration for research project in third and fourth semesters should be 08 hours per week per batch.
- Each of the course is divided into five units.
- The content of theory course / paper as well as laboratory (practical) course may be modified time to time (with the approval DC) to keep pace with the recent developments and trends in the subject.

Attendance:

Students must have 75 % of attendance in each core, foundation, elective, laboratory and research project course for appearing examination otherwise he / she will not be strictly 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.

Departmental Committee:

The existing Departmental Committee (DC) will monitor the smooth functioning of M. Sc. programme.

Results Grievances / Redressal Committee

Grievances / redressal committee will be constituted in the department to resolve all grievances relating to the evaluation. The committee shall consist of Head of the department, the concerned teacher of a particular course and senior faculty member of Department of Committee. The decision of Grievances / redressal committee will have to be approved by Department committee.

Evaluation Methods:

- The assessment will be based on 50: 50 ratio of continuous internal assessment (CIA) and semester end examination (SEE) with separate passing.

Continuous Internal Assessment (CIA):

- There will be 50 marks for Continuous Internal Assessment, 20 marks for internal / midterm test, 05 marks for attendance and overall performance, 10 marks for tutorials,05 marks for field assignment and 10 marks seminar presentation. There will be two midterm test (10 marks each) as a part of continuous internal assessment (CIA), first based on 50 percent of the syllabus taught and second based on remaining 50 percent of the syllabus taught. The score obtained from these two midterm test will be considered for the preparation of final sessional marks / grades. The setting of the question paper and the assessment will be done by the concerned teacher who has taught the course.

Semester End Examination (SEE) :

- The semester end theory examination for each theory course will be of 50 marks. The total marks shall be 100 for 4 credit theory course (50 marks semester end exam + 50 marks CIA) and 50 for 2 credit lab course (25 marks semester end exam + 25 marks CIA).

- Semester end examination (SEE) time table will be declared by the departmental committee (as per the university annual calendar). The paper setting and assessment of theory courses, laboratory courses and research project will done by external (50%) and internal (50%) examiners. However, in case of non-availability of external examiner for either paper setting or assessment or both, department committee will be empowered to take appropriate decision.

A. Structure for theory course for Internal Assessment.

Test-I	**Test-II**	**Two Tutorials/ Assignments**	**One Seminar**	**Attendance, Discipline & Overall performance etc.**	**Field Assignment**	**Total Marks**
10 marks	10 marks	10 marks	10 marks	05 marks	05 marks	50 marks

B. Structure **for lab course for Internal Assessment.**

Test-I	**Record**	**Field visit**	**Viva- voce & Overall performance etc.**	**Total Marks**
10 marks	05 marks	05 marks	05 marks	25 marks

The theory and practical examinations will be held at the end of each semester. There will be Separate passing (internal marks + external marks) after getting at least minimum marks in each paper.

Every student will have to complete 110 credits to obtain the Masters degree in Environmental Science having practical's/ laboratory work / Field work / demonstration work etc., of which 106 credits should be from their respective subject and four (04) credits from service courses

Pattern of semester end question paper will be as below:

- The semester end examination of theory course will have two parts (10+40 = 50 Marks)
- Part A will be consisting of 10 questions having 1 marks each (multiple choice questions / fill in the blanks/ answer in sentence) as compulsory questions and it should cover entire course curriculum (10 Marks)

- Part B will carry 7 questions. Therefore, students will have to attempt any five questions each of 8 marks.
- Number of sub questions (with allotment of marks) in a question may be decided by the examiner.
- Semester end practical examination (for laboratory courses) will be of 25 marks each (semester end examination only). Student must perform at least three experiments from each lab course. The final practical examination will be conducted at the end of each semester along with the theory examination.
- Semester end examination for project will be carried out in the respective semester.
- At the end of each semester the result will be forwarded to the Controller of the Examination through Departmental Committee in university departments and through Principal in colleges.
- The Head of the Department/ Principal shall send all results to the Controller of Examination for further processing.
- Every student will have privilege for revaluation of answer sheets or recounting of marks for each semester end examination. However, students will have to submit an application within 15 days from the date of declaration of results.
- Applications received for revaluation / recounting will be discussed in the Departmental Committee and examiners will be appointed accordingly.
- The results of revaluation / recounting will be approved by Departmental Committee/ Principal and forwarded to Controller of Examination for further processing.

Earning Credits:

At the end of every semester, a letter grade will be awarded in each course for which a student had registered. A student's performance will be measured by the number of credits that he/she earned by the weighted Grade Point Average (GPA). The SGPA (Semester Grade Point Average) will be awarded after completion of respective semester and the CGPA (Cumulative Grade Point Average) will be awarded at the end of the 4th semester.

Grading System:

- The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Master Programme. Grade points are based on the total number of marks obtained by him / her in all heads of the examination of the course. The grade points and their equivalent range of marks are shown in Table-I.

Table – I : Ten point grade and grade description

Marks Obtained (%)	Grade Point	Letter Grade	Description
90-100	9.00- 10	O	Outstanding
80-89	8.00-8.90	A^{++}	Exceptional
70-79	7.00-7.90	A^{+}	Excellent
60-69	6.00-6.90	A	Very Good
55-59	5.50-5.90	B^{+}	Good
50-54	5.00-5.40	B	Fair
45-49	4.50-4.90	C^{++}	Average (Above)
41-44	4.1-4.49	C	Average
40	4.0	P	Pass
< 40	0.0	F	Fail (Unsatisfactory
	0.0	AB	Absent

- Non appearance in any examination / assessment shall be treated as the students have secured zero marks in that subject examination / assessment.

- Minimum P grade (4.00 grade points) shall be the limit to clear / pass the course / subject. A student with F grade will be considered as 'failed" in the concerned course and he / she has to clear the course by appearing in the next successive semester examinations.

- Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and CGPA will be given on the completion of M. Sc. programme.

Computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average)

Grade in each subject / course will be calculated based on the summation of marks obtained in internal and semester end examination.

The computation of SGPA and CGPA will be as below

- Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and will be computed as follows.

$$SGPA = \frac{\text{Sum (Course Credit X Number of Grade Points in concern Course Gained by the Student}}{\text{Sum (Course Credit)}}$$

The SGPA will be mentioned on the mark sheet at the end of every semester.

- The Cumulative Grade Point Average (CGPA) will be used to describe the overall performance of a student in all semester of the course and will be computed as under.

$$CGPA = \frac{\text{Sum (All four Semester SGPA)}}{\text{Total Number of Semester}}$$

The SGPA and CGPA shall be rounded off to the second place of decimal.

Grade Card:

Results will be passed through the Departmental Committee / Principal and the grade card (containing the grades obtained by the student along with SGPA) will be issued by the university after completion of every semester.

The grade card will be consisting of following details.

- Title of the courses along with code opted by the student.
- Credits associated with the course.
- Grades and grade points secured by the student.
- Total credits earned by the student in a particular semester.
- Total credits earned by the students till that semester.
- SGPA of the student.
- CGPA of the student (at the end of the 4th semester).
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Cumulative Grade Card

The grade card sheet showing details grades secured by the student in each subject in all semester along with overall CGPA will be issued by the University at the end of 4th semester.

Semester - I

RM (ENV- 001:- Research Methodology – Part-I)

(Theory Course with 02 Credits)

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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	2 hr/week	Test	:-	10 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	15 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

Unit –I: **10+2**

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: **10+2**

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.

Current developments in the subject.

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, trouble shooting mechanism, field and laboratory problems.
3. Acquire knowledge of data collection, presentation of data, data analysis and presentation of samples.

References

1. Research Methodology-Methods and Techniques , By Kothari C.R.(2011); 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. "Fundametnals 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 & Bartjan Pennink, Springer.

Semester – I

FC (Env-401 :- Foundation Course on Environment)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Dynamics of ecosystems, energy flow in ecological system, nature of abiotic 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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - Ecosystem Dynamics : **10+2**

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, Cybernetic nature and stability of ecosystem, Concept of habitat, Ecological niche, Guild, concept of ecotone, Edge effect, Ecological succession, Mechanism of succession, Concept of climax , Concept of Gaia hypothesis.

Unit-II :- Restoration of Degraded Ecosystems: **10+2**

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-III :- Population and Community Ecology: **10+2**

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, Ecological sustainability.

Unit-IV :- Natural Resources : **10+2**

Renewable and non-renewable resources, Wild life resources, Water resources, Water use, Water conservation, Rain water harvesting, fishery resources, Mineral resources, Impact of over exploitation of mineral resources, Exploitation of metallic ores, Energy resources, Conventional and non-conventional energy resources, Natural resource conservation practices, Recycle, reuse and recovery of resources through 3 R principles.

Unit-V : Environmental Pollution: **10+2**

Air pollution **:-** Sources, Air pollution episodes and disasters, Industrial pollution, Major effects of air pollution, Control measures.

Water pollution **:-** Sources, Types, Water pollution episodes and disasters, Major effects, Monitoring and preventive measures.

Noise pollution **:-** Sources, Vibration and impact isolation, Monitoring of noise, Noise pollution control equipments, Noise standard and control measures.

Soil pollution **:-** Sources, Effects, Methods of soil reclamation, Soil conservation measures.

Radiation **:-** Major sources, Nuclear fusion and fission effects, Use of nuclear weapons and their consequences, Impact, Radioactive risk assessment and waste disposal practices.

Current development in the subject.

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) 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.
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

Semester – I

CC (Env-402 :- Environmental Chemistry)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Understand the basics of Environmental Chemistry
2. Acquire the knowledge of composition of Air, Water & Soil
3. Identify the chemical contamination in Environment.
4. Analyze process for Air, Water & Soil
5.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- Basic Concepts of Environmental Chemistry : 10+2

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, The Carbonate system, Unsaturated and Saturated hydrocarbons, Radionuclide.

Unit-II :- Chemical Agents in Environment: 10+2

Introduction, definition, Scope, Importance , Role of chemical agents in environment, Basic water chemistry, Chemical bonding, Solubilization, and ionization , 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, Data collection and record keeping.

Unit –III :- Chemistry of Air : **10+2**

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.

Unit –IV :- Chemistry of Water and Soil: **10+2**

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 :-Global warming and green house gases : 10+2

Global warming, Effects, Control of global warming, Carbon sequestration, International agreements, Green house gases , Impact on global climate, Consequences of green house effects, Impact of global warming, Formation of ozone, Mechanism of ozone depletion , CFC and ozone layer depletion, Chemistry of photochemical smog, HCFC, No_2, HC and PAN, Chemistry of cleaning agents, Soap, Detergents and bleaching agents, Chemistry of colloids, Gasoline and additives antiknock compounds, Lubricants and greases, Biogases.

Current development in the subject

Course Outcome

Students should able to:

- Define basics of environmental chemistry.
- Explain chemical contamination in environment
- Analyze air, water and soil.
- Apply the knowledge to assess the contamination of environment.

References

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

Semester – I

CC (Env-403 :- Environmental Instrumentation and Analysis)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to

1. Study different sampling techniques, sampling equipments, sample preservation and processing of air, water and soil samples.
2. Use instruments for Studies.
3. Know analytical Instrumentation.
4. Apply Knowledge of instruments in Environmental Fields.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - Introduction and sampling techniques: **10+2**

Samples preparation, preservation and processing of air, water and soil samples, sampling equipments, separation and sampling techniques, precipitation, fractional crystallization, fractional distillation, solvent extraction, accuracy and precision, types of errors, trouble shooting of instruments.

Unit – II: - Chromatography: **10+2**

Theory, Principles , working, methods and application of Thin Layer Chromatography (TLC) , Gas Chromatography (GC) , High Performance Liquid Chromatography (HPCL), Gas Liquid Chromatography (GLC), Ion Exchange Chromatography

Unit-III: - Spectrophotometry : **10+2**

Theory , principles, working methods, and application of colorimeter and spectrophotometer, ultra violet (UV) spectrophotometer, Infra Red (IR) spectrophotometer, Nuclear Magnetic Resonance (NMR), Atomic Absorption Spectrophotometers (AAS), flame photometer , fluoride meter, Conductivity meter, Nephlometer turbidity meter , pH meter .

Unit-IV: - Air Sampling Equipments: **10+2**

Theory and applications of High Volume Air Sampler (HVAS), Respirable Suspended Particulate Matter (RSPM) measurement 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 analyzers and chemiluminescent analyzer .

Unit-V :- Microbiological instruments and Equipments: **10+2**

Theory, principles, working and application of Colony Counter, Autoclave, Oven, Incubator, Laminar air flow and BOD incubator

Current developments in the subject

Course Outcome

Students should be able to:

1. Define sampling techniques, instrumental trouble shooting
2. Apply applications in pollution studies.
3. Categorize analytical instruments and instruments used for environmental problems.
4. Create consultancies.

Reference:

1. Analytical chemistry -Gary D..Christian.
2. Hand book of analytical instruments- Khandpur R.S.
3. Instrumentation methods for chemical analysis-B.K.Sharma
4. Instrumentation methods for chemical analysis- Chatwal and Anand
5. Instrumental methods of analysis : Willered merit and Dean (CBS publication , New Delhi)
6. Instrumental methods of Environmental analysis : Karan saveen (sarup and sons publishers, New Delhi) (2001)
7. Instrumental methods of chemical analysis: H.Kaur, Pragati prakashan, merrut. (2009)
8. Instrumental analysis for science and technology : W. Ferren (Agrobios Indian, Jodhpur).
9. Instrumental methods : V.B.Borade, Nirali prakashan, Mumbai.
10. Instrumental Methods of Analysis : G.W.Ewing.
11. Instrumental Analysis: gurdeep Chatwal (Himalaya Publishing House, New Delhi, (2000)

Semester – I

EC (Env-421 A :- Wildlife Conservation and Management)

(Theory Elective Course with 04 credits)

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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- Introduction to wildlife : **10+2**

Definition and concept 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 : **10+2**

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 : **10+2**

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

Unit – IV :- Wildlife Conservation : **10+2**

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:- Wildlife Management: **10+2**

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.

Current developments in the subject.

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 Diseases and Disorders, Arora dn Bipulchakraborthy 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, katwal/ 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.

Semester – I

EC (Env-421-B :- Environmental Meteorology & Geosciences)

(Theory Elective Course with 04 credits)

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 mansoon 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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - Climate: **10+2**

Weather, Climate, Physiographic and geological homogeneity of India, Geo-economic significance, Major climatic regions of the world based on latitude and distribution of vegetation, Condition of climate, Classification of climates, Criteria for classification, Thornthwaites and Koppens classification.

Unit –II: - Climates of India: **10+2**

Climates of India, Indian mansoon, Jet streams general circulation, The seasons mechanism of mansoon, Forecast of mansoon 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, (El-Nino, droughts, tropical cyclones and western disturbances, IPCC, UNFCC, Kyoto protocol)

Unit – III: - Meteorology: **10+2**

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 – IV: - Environmental Geosciences : **10+2**

Fundamental concepts, Earth system and biosphere, Conservation of matter in various geosphere, lithosphere, Hydrosphere, Atmosphere and biosphere, Energy budget of the earth, Earths thermal environment and seasons, Mineral structures and their compositions, Trace elements and their partitioning during mineral formation.

Unit – V: - Earths Processes and Geological hazards : **10+2**

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.

Current developments in the subject.

Course Outcome

Students should be able to:

1. Classify different climatic regions of the world, distribution of vegetations and climatic conditions in India.
2. Compare the various seasons in India, distribution of rainfall, monsoon forecast and climatic conditions, in agricultural and industrial sectors.
3. Identify the meteorological parameters to forecast the weather, scale of meteorology and establish ambient and emission standards.
4. Assess different earth process, natural cycles and risk of geological hazards.

References

1. The Atmosphere : An Introduction to meteorology :- Frederic K. Lutgen E.J.Tarbuck.
2. Climatology ;Selected Application :-Henry D.Foth
3. Climatology: Fundamentals and Application:-Mater J.R.
4. Air pollution:- V.P. Kudesia Pragati Prakashan Meerut
5. Environmental Science :- A study of interrelation ship E.D. Enger,B. E. Smith, 5th ed; WCB Publication.
6. Fundamental of Ecology :- E.P. Odum, Revised Edition 1995-96 Edition 2003.
7. A Manual of Air Quality Monitoring :- NEERI Publication.
8. Environment, Energy, Health, Planning, for Conservation:-V. Vidyanath, Gyan Publication house, New Delhi.
9. Meteorology of Air Pollution :-R.S. Scores 1990 Ellis Hardood Pub.
10. Fundamentals of Air Pollution:- 2nd Ed. Arthur Co Stern Acad. Press 1984.
11. Air Pollution :- M.N. Rao, Mcgraw Hill 1993.
12. General Meterology :-Horace Robert Byers, Sc.D. 3rd Ed MCGRAW Hill Book Company new York Toronta, London.
13. Enviromental Chemistry :- A.K.De. Wiley Interscience.
14. Environmental Chemical Analysis :- Lain L. Marr, Malcom S. Cresser, international text book company, USA.
15. Environmental Geology : K.S Valdiya Indian Context Tata McGraw Hill Publication Co. New Delhi, 1987.
16. Environmental Geology : Barbara, Wim Brain, J.S. Stephan, C.P John Wiley & Sens. Inc
17. Environmental Geology : Lundegran, Lawarence Prentice Hall
18. Geo Environmental Engineering : Reddic, Tecnip books international, New Delhi.
19. Text of the Kyoto Protocol on www.unfccc.int.

LC: ENV 441:Lab Course – I
(Based on CC Env. 401)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. Determination of primary production as GPP & NPP by light and dark bottle technique.
2. Identification and enumeration of phytoplankton in water body.
3. Identification and enumeration of zooplanktons in water body
4. Ecological adaption of hydrophytes, mesophytes and xerophytes.
5. Quantitative analysis of planktons by Sedgwick rafter cell method.
6. Estimation of biomass from grassland by harvest method.
7. Productivity study of grassland ecosystem by harvest method.
8. Determination of relative density relative frequency and relative abundance of species by using simulation.
9. Profile study of natural pond/lake and manmade reservoir.
10. To study fresh water resources water quality parameters like pH, EC, total acidity , total alkalinity, DO, CO_2, TS, TDS, TSS, BOD, Colifom, MPN, etc.
11. To study the cover and based area study of tree species
12. To study the light intensity by sunshine record.

Field activities:
1. Visit to aquatic ecosystem for collection of water and plankton samples.
2. Visit to terrestrial ecosystem for productivity studies.
3. Study of wetland Flora and fauna and the status study.

LC: ENV 442:Lab Course – II
(Based on CC Env. 402)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 .

LC: ENV 443:Lab Course – III
(Based on CC Env. 403)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 biomonitoring .

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

LEC (ENV 444 – A :Lab Course – IV)

(Based on EC Env. 421 -A)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 artifacts.
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.

LEC (ENV 444-B :Lab Course – IV)

(Based on EC Env. 421-B)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 at carbon dioxide from air by using Lungs Zincondroff apparatus.
10. Determination of NO_x in ambient air by high volume sampler (HVS).
11. Measurement of SO_X by high volume sampler (HVS).
12. Measurement of SPM by using high volume sampler (HVS).
13. Measurement of RSPM by using Respirable Dust Sampler.
14. Determination of atmospheric lead & other metals by using impinger techniques and AAS.
15. Identification of minerals on the basis of physical properties (10 minerals specimens).
16. Identification of rocks: Igneous rock, sedimentary rock and metamorphic rocks.
17. Smoke monitoring by ringle chart.
18. Determination of polynuclear aromatic hydrocarbon from air.

Semester - II

RM (ENV- 002 : Research Methodology – Part-II)

(Theory Course with 02 Credits)

Course Objectives

1. Students can collect the research data through experimentation, questioner, by direct observations and sensitivity study of spatial and temporal data.
2. Students will know importance of statically analysis, errors occurring in the collected research data and proper interpretation of produced research.
3. 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

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	2 hr/week	Test	:-	10 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	15 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

Unit-I: **10+2**

Data collection by questioner method by field visit and by direct observations, Measurements and experimentation, Measures for maintaining accuracy in data, Sensitivity study of data spatial and temporal data.

Unit- II : **10+2**

Statistical analysis of data, Determination of mean, Median, mode, Dispersion, standard deviation, Stander errors of data, Co-relation study, Significance of studies and Regression analysis of data.

Unit- III : **10+2**

Interpretation of data, 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, Report writing, Steps in writing report, Layout of research report , Types of reports, review article writing.

Current developments in the subject.

Course Outcome

Students should be able to:

1. Collect research data through experimentation, questioner y by direct observations and sensitivity study of spatial and temporal data.
2. Infer the importance of statistical analysis, errors occurring in the collected research data and proper interpretation of produced research
3. 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 Kotharir C.R.(2011); 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. "Fundametnals 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 & Bartjan Pennink, Springer.

Semester – II

CC (Env-404 :- Environmental Biotechnology)

(Theory Core Course with 04 credits)

Course objectives

1. Student will know the concept of biotechnology, its scope and status in India.
2. Students will be able to assess the role of biotechnological tools in pollution abatement while studying the techniques like RBC, ASBR, APBR, and AFEBR.
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 of xenobiotics, regulation of bio-safety protocols and development of transgenic research in India.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- Understanding of Biotechnology : **10+2**

Definition, scope and concept of biotechnology, biotechnological vision and interdisciplinary activities, (strain choice, mass culture, optimization of cell response, process, operations and product recovery), biotechnological status in India.

Unit-II :- Biotechnology for Pollution Abatement: **10+2**

Air pollution abatement : Biological process, aerobic anaerobic biological treatment, activated sludge process, sequence batch reactors, rotation biological contractors (RBC), fluidized bed reactor, anaerobic sequencing batch reactor (ASBR), anaerobic packed bed reactor (APBR), anaerobic fluidized expanded bed reactor (AFEBR), two phase anaerobic digester.

Unit –III :- Bioremediation and Phytoremediation: **10+2**

Principle and concept of bioremediation , agents of bioremediation, In-situ and Ex-situ bioremediation, bio-possibility application ,metal phytoremediation, phyto transformation, advantages and limitations of phytoremediation, role of genetics in phytoremediation.

Unit –IV :- Bio-composting and Integrated pest Management: **10+2**

Natural composting, vermin composting technology, bio-fertilizers, bio pesticides, biosensors, biodegradation of xenobiotics ,GMOS, gene bank.

Unit – V :-Bio-safety: **10+2**

Cartagena protocol, biosafety regulations, scope of biosafety, regulatory framework, biosafety assessment and decision making, development in transgenic research and its application in India.

Current development in the subject.

Course Outcome

Students should be able to:

1. Classify the concept of biotechnology.
2. Illustrate the regulations of biosafety protocols.
3. Assess biotechnological tools in pollution studies.
4. Design reactors for treatability studies

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

Semester – II

CC (Env-405 :- Green Technology)

(Theory Core Course with 04 credits)

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 nano tubes, 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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- Overview, Principle, concepts and tools of Green Technology: 10+2

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: 10+2

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: 10+2

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 : 10+2

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 :-Environmental Engineering and Pollution Prevention: 10+2

Separation technique for removal and recovery of pollutants, socio-economic aspects recovery waste as abatement, end of pipe solutions, life cycle analysis of plastics, palters, tins, identification of waste streams from process, waste minimization strategies, prioritizing pollution prevention options, selecting environmentally compatible materials , design of unit operation for pollution prevention, economics of pollution prevention, process flow sheeting for pollution prevention.

Current development in the subject.

Course Outcome

Students should be able to:

1. Define the concept and application of green chemistry foir 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.

References

1. M.H. Fulekar (2010) Nanotechnology Importance and application , I K international publishing house Pvt.Ltd.
2. Lynn goldman, Cristine Coussens, Implications of nanotechnology for environmental health research < National Academic Press, Washington, 2007.
3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker: New York, 2001.
4. Anastas , P.T.Warner,, J.C. Green chemistry : theory and Practice. Oxford Univ.Press : oxford,1998.
5. Lynn E.Foster : Nanotechnology : Science, Innovation , and Opportunity, December 21, 2005, Prentice Hall.
6. Fei wang & Akhlesh Lakhatakia (eds) (2006) . Selected Papers on Nanotechnology- Theory & Modeling ()Milestone Volume 182. SPIE Press.
7. Caye Drapcho, Nhauan Phu Nghiem, Terry Walker (2008). Biofuels Engineering Process Technology. (McGraw-Hill).
8. Akhlesh Lakhtakia (ed) (2004) . The handbook of Nanotechnology, Nanometer structures : Theory, Modeling and Simulation. SPIE Press, Bellingham, WA,USA.
9. Rebecca L. Lankey, Paul T.Anastas, "Advancing Sustainability through Green Chemistry and Engineering" (ACS Symposium Series)
10. Varma, R.S,Advances in Green Chemistry : Chemical Syntheses using Microwave Irradiation, Kavitha printers: Bangalore, india,2002.
11. Martin Charter and Ursula Tischner Sustainable solution : Developing products and series for the future Greenleaf Publishing.
12. Lancaster, M. Green Chemistry : An Introductory Text, Royal Society of Chemistry : Cambridge, 2002.
13. Allent, D.T. and D.R.Shonnard, Green Enginnering: Environmentally conscious desing of Chemical processes, Prentice hall PTR : Upper Saddle River, NJ, 2001.
14. Matlack. A.S. Introduction to Green Chemistry marcel Dekker: New York, NY, 2001

Semester – II

CC (Env-406 :- Environmental Engineering and Technology)

(Theory Core Course with 04 credits)

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 explain 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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- **10+2**

Water and wastewater treatment and analysis, introduction, various steps in water treatment, sedimentation, filtration, disinfections, removal of iron and manganese, softening of water, taste and odour removal, advanced technologies for wastewater treatment – ozonation , fluoridation, reverse osmosis, electro dialysis, desalination and ion exchange methods.

Unit-II :- **10+2**

Industrial wastewater treatment, general characters of wastewater, theories of treatment, effluents treatment methods for dairy, pulp & paper, sugar, distillery, iron and steel, air pollution monitoring and control techniques, sampling and monitoring of gaseous and particulate pollutants, ambient and stack emission monitoring, bio filters and prevention of indoor air pollution.

Unit –III :- **10+2**

Hazardous waste treatment , sources and characteristics, treatment and disposal, soil pollution control techniques and monitoring, introduction, sources, treatment of soil pollutants.

Unit –IV :- **10+2**

Solid waste treatment and management , Introduction, waste generation and characteristics, processing, physical, chemical and biological treatment, recycling, current management practices.

Unit – V :- **10+2**

Environmental Engineering and biotechnology, introduction, scope and application, detoxification of phenols and biodegradation of pesticides, application of biotechnology for the treatment of high street waste e.g. whey and spent wash, primary and secondary sludge phenol and cyanide removal .

Current development in the subject.

Course Outcome

Students should able to:

- Define hazardous and non-hazardous waste treatment methods.
- Express the functioning of effluent treatment plant
- Use the treatment methods for hazardous and non hazardous waste management.
- Analyze the hazardous and non hazardous waste
- Design the different hazardous waste treatment methods

References

1. Rao C.S., 1991, Environmental Pollution control Engineering, wing Eastern Ltd., New Delhi.
2. Pandey G.N. and Carney G.C., 2002 , Environmental Engineering, Tata Mcgraw-hll Pub.Co., New Delhi.
3. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice hall of India Pvt. Ltd., New Delhi.
4. Al-sulaimi, J. and T.Asano.2000. Water reclamation and reuse, new age international publisher, new Delhi.
5. American Public health Association (APHA), 1992.Standard methods of water and waste water analysis, Washington D.C.
6. De,A.K. Environmental Chemistry, new Age International Pvt.Ltd, New Delhi.
7. Gujar, B.R. 2001, Sludge treatment and siposal. oxford and IBH publishing co. Pvt.Ltd, New Delhi.

Semester – II

EC (Env-422 A:- Environmental Management Systems)

(Theory Elective Course with 04 credits)

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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit –I: Environmental Management: 10+2

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: 10+2

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: 10+2

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: 10+2

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 : Fair Environmental Practices: 10+2

Total quality management and business environment; Business ethics, Traditional trade and commerce practice and fair environment practice, Quality management and its impact on human society, Environmental initiative and national environmental policies; Environmental initiatives at national and global level; National environmental policies and its implementation structure; Role of NGO's and public participation in environment movements; International environmental initiatives-Stockholm's declaration, Rome report, Ramsar convention on wetlands, Vienna convention and Montreal protocol, Earth summit, Kyoto protocol.

Current developments in the subject.

Course Outcome

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.
4. 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

1. Environmental planning, policies and programs in India-K.D.Saxena.
2. Vijay Kulkarni and T V Ramchandra. "Environmental management" Capital Publishing.
3. T V Ramchandra, "Management of Municipal Solid Waste" Capital Publishing.
4. Sustainable development (Vol.I & II): N.L.Gupta and K.K. Gurjar(ed); Rawat Publications.
5. Environmental management: G.N.Pandey; Vikas Publication House.
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.
10. Environmental Management – Vijay kulkarni and T.V.Ramchandra capital publishing.
11. Solid waste Engineering : Priciples and management issues, Geroge teho Banglor.

Semester – II

EC (Env-422 B:- Environmental Statistics & Modeling)

(Theory Elective Course with 04 credits)

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.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit - I:- Fundamental Concepts in Environmental Statistics: **10+2**

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, 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.

Unit-II:- Probability: **10+2**

Concept of probability, Addition and multiplication theorem of probability, Conditional probability and unconditional probability, Problems on probability, Poisson and Binomial distribution.

Unit- III:- Statistical testing: **10+2**

Concept and types of hypothesis, Null and Alternative hypothesis, Tests of hypothesis- t test, F test, Z test and Chi-square tests, ANOVA test, Concept of, regression analysis, Regression Equation -X on Y and Y on X.

Unit - IV:- Computer applications: **10+2**

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 Modeling: **10+2**

Introduction to environment system analysis, Modeling concept, Linear, simple and multiple regression models, Validation and forecasting, Population growth model, Lotka Volterra model, Gaussian plume model, Box model, Point source stream pollution model, Cost-Benefit analysis.

Current developments in the subject

Course Outcome

Students should be able to:

1. Apply the fundamental concepts of statistics in environmental analysis.
2. 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.

LC: ENV 445:Lab Course – V
(Based on CC Env. 404)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 Agar.
10. To study the growth pattern of salmonella on xylose-lysin-agar medium.

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.

LC: ENV 446:Lab Course – VI

(Based on CC Env. 405)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 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 ecollabelling 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.

LC: ENV 447:Lab Course – VII

(Based on CC Env. 406)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. Determination of Biological Oxygen Demand in waste water
2. Solve the given problems on BOD.
3. Determination of Chemical Oxygen Demand in 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. Analysis of chemicals used in waste and waste water treatment :
   i. Analysis of alum Non-ferric alum
   a. Determination of water insoluble matter in non-ferric alum
   b. Determination of water soluble aluminum compounds as Alumina (Al_2O_3) from alum by using gravimetric method.
   c. Determination of water soluble aluminum compounds as Alumina (Al_2O_3) from alum by using volumetric method.
8. Analysis of activated carbon
   a. Determination of moisture content in activated carbon.
   b. Determination of adsorbing power of activated carbon.
9. Analysis of bleaching powder.
   a. Determination of available chlorine in bleaching powder.
   b. Determination of stability of bleaching powder.
10. Analysis of caustic soda
    a. Determination of sodium hydroxide content from caustic soda.
    b. Determination of silicates from caustic soda.
    c. Determination of sulphates from caustic soda.
    d. Determination of chlorides from caustic soda.
11. Analysis of filter sand:
    a. Determination of effective size and coefficient of uniformity of filter sand
    b. Determination of bulk density of filter sand.
12. Lime analysis:
    a. Determination of moisture content in lime powder.
    b. Determination of percentage of oxides and hydroxides in lime.
    c. Determination of 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.

LEC: ENV 448- A :Lab Course – VIII

(Based on EC Env. 422 -A)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. Study on International and National standard of Air, Water and Soil
2. Study in detail on Environmental accounts and auditing, green funding and taxes trade and environmental management in any two industrial units.
3. To evaluate the adverse effect of lack of environmental planning in industries (any two)
4. To prepare base line data on water, soil , air, natural assets, demography , and heritage of any two project areas.
5. Study of rural and urban environmental planning at regional level.
6. Study on resource planning at regional and national level.
7. Study on Gandhian concept of self relied villages.
8. Study of ISO: 14000 and OSHAS 18000
9. 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.

LEC: ENV 448- B :Lab Course – VIII

(Based on EC Env. 422 -B)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. Calculation of mean, mode & median of data.
2. Calculation of standard deviation of data.
3. Calculation of co-efficient of variation of data.
4. Calculation of Karl Person's Co-efficient of Co-relation.
5. Calculation of Regression equation Y on X & X on Y from the data.
6. Calculation of variance from data.
7. Calculation of standard error (SE) from data.
8. Problems on probability.
9. Problems on t-test.
10. Problems on Z-test.
11. Problems on f-test.
12. Problems on ANOVA.
13. Problems on Chi-square test.
14. Application of Power point presentation in environmental data presentation.
15. Use of MS-Excel in environmental data analysis.

Semester – III

CC (Env-501 :- Municipal & Hazardous waste Management)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Current Scenario of MSW, Model's for appropriate waste collection.
2. Management & Handling Rules of MSW.
3. Identification of Hazardous Waste sources & Characteristics.
4. Designing & Operation facilities for Hazardous waste.
5. Bio-Medical Handling & Management Rule's 2008

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I- Introduction

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

1. Anaerobic Digestion, 2. Aerobic Digestion, 3. Vemi composting, 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

Source Reduction, Green Product Design Strategies, 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, Aluminium), Reuse , Remanufacture, Recover(Energy Recovery & Material Recovery) Case Study (Polystyrene Cups, Soft-Drink Containers).

Unit- IV- Hazardous Sources and Management

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.

Unit-V- Hazardous treatment Methods

Hazardous waste treatment and Design: Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste –Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation –remediation of hazardous waste disposal sites. Biomedical Waste management: Biomedical (Handling and Management) Rules 2008, sources, treatment and disposal.

Current development in the subject.

Course Outcome

Students should be able to:

1. Discuss current scenario of MSW, models for appropriate waste collection.
2. Apply management and handling rule of MSW
3. Differentiates of hazardous waste sources and characteristics
4. Create designing and operation facilities for hazardous waste
5. Evaluate biomedical handling and management rule 2008

References

1. George Tchobanoglous et.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 Tchobanoglous et.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.

Semester – III

CC (Env-502 :- Remote Sensing and GIS Application for Environmental Management)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Types of Aerial Photography, Photo Interpretation & Mapping of Objects.
2. Scope of Remote Sensing & there Application.
3. Scope of GIS, Advance's in GIS & the application of GPS.
4. Applications of RS & GIS for soil erosion, flood Mapping, wildlife, grassland status.
5. Wildlife conservation & Management, urban planning & GIS in Disaster Management.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: Aerial Photography and Photogrammetry:

Sensory organ eye and camera, Working principle of camera, Camera types, cameras used in aerial photography, Aerial photography- history of aerial photography, Platforms used in aerial photography, Methods of aerial photography, Types of Aerial photographs (vertical & oblique photographs), Geometry of aerial photographs, Scale of aerial photographs; Stereoscopic vision , Stereoscopes, stereoscopic photographs, Parallax bar, Photogrammetry – Photo interpretation, mapping of objects from aerial photographs.

UnIt-II: Remote Sensing:

Introduction and scope of remote sensing, Stages in remote sensing, Fundamental principle of remote sensing- Electromagnetic spectrum, Transmission, Absorption, Reflection, atmospheric scattering, emissivity, Radiant energy and its interaction with matter and earth surface and atmosphere, spectral signature, Platforms in remote sensing, Active and passive remote sensing, Remote sensing sensors.

Unit-III: Satellite Remote Sensing:

Polar and geostationary satellites, Meteorological satellites and non-meteorological remote sensing satellites, Landsat, Spot, IRS, ERS, JERS, Quickbird; Sensors-Pushbrooom and Whiskbroom types, Data reception, Archiving and distribution of data, Radar and LIDAR as Active Remote Sensing Systems, Working of Radar, Satellite images, Radar Images.

UNIT-IV: Geographic Information System (GIS):

Definition, Scope of Geographic Information System, Capabilities and advances of GIS, Use of GIS in spatial and temporal analysis, Components of GIS system , GIS software's ; Digital Image processing- Image structure, Raster and Vector data types, Image enhancement and rectification, Band combination, Geo referencing the data, Image classification, image interpretation. Geographical Positioning System, Applications of GPS.

UNIT-V: Application of RS and GIS:

Application of RS& GIS - in Environmental Systems , soil erosion study, flood mapping and flood damage study, Agricultural study, Natural resources study such as Water, soil, wildlife, Grassland, minerals & Metals etc. ;Use of RS &GIS in Environmental Audit. Use of RS&GIS in Environmental Management study- in soil Conservation and Management, in Water Shade Management, in forest conservation & management, in wildlife conservation and management, in Urban Planning. Use of RS and GIS in Disaster management

Current development in the subject.

Course Outcome

Students should be able to:

1. Define and discuss the concepts and components of aerial photographs
2. Summarize the principle and procedure of remote sensing
3. Identify and use the different types of satellite images and aerial photographs
4. Illustrate the use of GIS software for extraction of information and interpretation
5. Demonstrate the use of RS and GIS in environmental study and management

References

1. Remote Sensing and Image Interpretation:-Tomas M.Lillesand and Ralph W.Keifer john Wiley and sons Inc. New Yark.
2. Introduction to Remote sensing:-James B. Campbell, Tylor and Franeis Ltd.Londan.
3. Fundamentals of GISN:-Michael N.Demers..
4. Remote Sensing application in applied geosciences:-Sumitra Mukherjee, Milton Book Company.
5. Environmental Geography:-H.M Saxena, Milton Book Company.
6. Principles of Photogeology:-Singh.
7. Principles of Remote Sensing:-Currain.
8. Fundamentals of Photogeology:-S.N.Pandey.
9. PC Software made simple:-Taxali.
10. Illustrated lotus 1-2-3:-by Muller.
11. Principles of Remote Sensing:-A.N.Gatel and S.Singh, Scientific Publishers (India). Jodhpur (1999Edition).
12. Remote Sensing for Environment and Forest Management:-A.Mehrotra and R.K.Suri. Indus Publishing Co.New.Dehli(1994 Edition)
13. Remote sensing for large wildfires:-E.Chuvieco, Springer, New York (1999 Edition).
14. Remote Sensing in Geoscience:-Tripathi N.K.
15. Remote sensing and GIS for site characterization;-Application and standard:-Singhroy, Technip Books International New Delhi.
16. Environmental Remote Sensing:-Saumirta Mukherjee**.**

Semester – III

CC (Env-503 :- Environmental Toxicology and Biodiversity Assessment)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Scope of Toxicology, Source's of Toxicants in Atmospheres, Hydrosphere & Soil.
2. Recent Trend's in pesticides, factors affecting metabolism of Xenobiotics.
3. Bio-assay Test, Protocol of Toxicity Evaluation.
4. Important of Biodiversity, Causes of Loss of Biodiversity.
5. Need of Biodiversity Assessment, Biodiversity Measurements & Extinct Species.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

UNIT- I : Introduction to Toxicology:

Scope of toxicology and eco-toxicology, Branches of toxicology - clinical, environmental, economic, forensic, industrial, genetic, systemic and behavioral; Environmental toxicology- environmental toxicants - toxicant in atmosphere, toxicants in hydrosphere, toxicant in soil; Source of toxicants / poisons in atmosphere, hydrosphere and soil; Acute toxicity, Chronic toxicity and Safe concentration; Neurotoxicity, carcinogenicity and mutagenicity.

UNIT-II: Classification of toxicants:

Natural and synthetic, Pesticides- classification of pesticides, mode of action of pesticides; Recent trends in the use of pesticides; Plant toxins- Aflatoxins, ergots, pyrethroids; Heavy metal toxicants and their toxicity - lead, arsenic, mercury, cadmium and chromium, copper; Zink; Xenobiotic components- Factors affecting metabolism of xenobiotics; Exposure of toxicants- Routes and sites of exposure, types of exposure - acute and chronic, Dose- response relationship, Dose response curve; Translocation of toxicants - absorption, distribution and extraction; Mechanism of action of toxicants; Selective toxicity; bioaccumulation of toxicants.

UNIT-III: Bio-assay:

Bio-assay tests, Concept of lethal concentration and lethal dose, Protocol of toxicity evaluation of toxicants, Determination of LC_{10}, LC_{50} & LC_{90} for exposure period, Tests for assessing carcinogenicity and mutatoxicity of toxic compounds, TLC techniques for determination of toxicants in water and vegetables samples

Unit-IV: Introduction to biodiversity:

Importance of biodiversity; value of biodiversity; Types of biodiversity- alpha and beta biodiversity; genetic diversity, species diversity and ecosystem diversity; causes of loss of biodiversity; measurements of biodiversity; listing of threatened biodiversity;

Unit-V: Biodiversity Assessment :

Need of biodiversity assessment, Qualitative and quantitative assessment, Biodiversity measurement methods, Diversity indices – Species richness indices, Species evenness indices, Wildlife status- Abundant, Threatened, Endangered, Greatly endangered, Extinction prone and Extinct species.

Current development in the subject.

Course Outcome

Students should able to:

1. Describe the basic principle of environmental toxicity.
2. Apply the different toxicity tests and protocols of toxicity.
3. Categorize toxicants and biodiversity.
4. Assess the biodiversity.

References

1. Principles of Environmental toxicology:-Ian C.Shaw and John Chadwick, Taylor and Francies.
2. Environmental Toxicology and Chemistry:-Donald G. Crosfy 1998
3. Text book of modern Toxicology:- David A. Wright and Pamela Welbourn Cambridge University Press 2002.Ernest Hodgsen and patricia E.levi Appleton and Lange Stamford etc U.S.A.1995.
4. Basic Toxicology:- Frank C. Lu, Homisphere publishing Corporation, New York, Washington 1993.
5. Essentials of Toxicology: - Loomis TA, Leae Fabiger.
6. Toxicology:-Hayes.
7. Principles of toxicology:-Cassarett and Doulls.
8. Biodiversity and environment – S.K. Agrawal
9. The Biological Diversity Act. 2002 and Biological diversity rules 2004-National Biodiversity Authority India. 475, 9th South cross stree, Kalpalocwar Nagar, Neelangarai, Chennai-600041
10. Biodiversity measurement and estimation D.L. Hawks
11. Biodiversity conservation-Global agreements and national concerns. RAMSAR sites CBD, Quarantine, Regulation, National Forestry policy, Biodiversity Act, Wild life protection Act.

Semester – III

EC (Env-521-A :- Environmental Plan, Policies and Legislation)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Environmental Management Plan (EMP).
2. Need & Law, Importance of Environmental Legislation.
3. Prevention & Control Rules & Regulations.
4. Government Policies for Protection & Development of Environment, Concept of Green Building.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit- I: Environmental Management Plans (EMP):

- Conceptualization: preliminary environmental assessment
- Planning: detailed studies of environmental impacts and design of safeguards
- Execution: implementation of environmental safety measures
- Operation: monitoring of effectiveness of built-in safeguards

Unit-II:

General: Need of laws, Importance of environmental legislation, National Environmental Policy Act (NEPA), History of environmental laws in India- Laws about environment in historic period, Laws about environmental component adopted during British rule – The Indian Forest Act, 1927.

Environment: -Environmental (Protection) Act, 1986; Environmental (Protection) Rules, 1986; The Hazardous Waste (Management and Handling) Rule, 1989; The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996; The Bio-Medical Waste (Management and Handling) Rules, 1998; The Recycled Plastics Manufacture and Usage Rules, 1999; The Noise Pollution (Regulation and Control) Rules, 2000; The Municipal Solid Wastes (Management and Handling) Rules, 2000. CRZ Notification of 2011.

Unit- III:

A] Air: - The Air (Prevention and Control of Pollution) Act, 1981; The Air (Prevention and Control) Rules, 1982.

B] Water: - The Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Rules, 1975. C] Forest: - The Forest Conservation Act, 1980; The Forest (Conservation); Rules, 1981; The National Forest Policy, 1988. D] Wildlife: - The Wildlife (Protection) Act, 1972; The Wildlife (Protection) Rules, 1995; The Recognition of Zoo, Rules, 1992.

Land acquisition Act, Land Acquisition R&R bill, state laws / Policies on R& R

Unit IV: Environmental policy:

Government policies in the protection and development of environment – environmental considerations in economic planning and development in India. Public policy strategies in pollution control. Environmental policy resolution. NCEP and district environmental status report preparation. Environmental forest clearence processes, National Green Tribunals (NGT). Concept of Green building, criterial and coponent in green building design.

Unit V:

A) Stockholm Conference; Earth Summit, Johansburg Summit, Rio Declaration, Agenda 21; United Nations Environment Programme (UNEP), International Union For Conservation of Nature and Natural Resources (IUCN), World Water Council (WWC), World Health Organization (WHO), World Wide Fund for Nature (WWF).IPCC.

Current development in the subject.

Course Outcome

Students should be able to:

1. Describe environmental management plan (EMP), environmental rules, laws and policies.
2. Explain need of lows, importance of environmental legislations, governmental policies for protection and development of environment.
3. Rearrange prevention and control rooms, regulations and governmental policies.
4. Design various strategies of pollution control techniques, green buildings, NCEP and environmental policies resolutions.

References

1. Hand Book of Env. Laws, Acts, Rules, Guidelines, Compliance and Standard Vol. 1 & 2: R. K. Trivedy Environmental Edition: 1st 1996.
2. Pollution control Acts, Rules and notifications issued there under: Central Pollution Control Board April. 1995.
3. Environmental Protection and the Laws: C. N. Mehta, 1991.
4. Legal aspects of Environmental Pollution and its Management: Ed. S. M. Ali, 1992.
5. International Environmental Policy Emergence and Dimensions: by L. K. Caldwel 1990.
6. Lal's Commentevis on water, Air pollution laws along with the environmental (Protection) Act and rules 1986, 3rd Rd. 1992: Law Publisher India.
7. Universal Environment and Pollution law manual: S. K. Mohanty 1998.
8. Pares Distn. Environmental Laws in India: (Deep, Lated Edn).
9. Environmental Problems, protection and control Vol I & Vol II Ed: Arun Kumar.

Semester – III

EC (Env-521-B: - Ecological Foot Prints & Carbon Sequestration)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Concepts of Ecological Footprint, Carbon capturing for sustainable future.
2. Carbon Emission and Global issues and remedial measures.
3. Types of carbon sequestration, Carbon sequestration as green house mitigation policy.
4. Pattern of energy use, carbon credit, trading and tax.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I: Carbon footprints and Sustainability:

Concept of ecological footprints, origin of ecological footprints, ecological footprint and policy development, ecological foot print and sustainability indicators, Environmental ethics, consumerism and carbon emission trends, comparison of rural and urban consumerism, sources of carbon emission, carbon footprints and ecological stability India's ecological footprint, concept of sustainable human society, carbon capturing for sustainable future.

Unit II: Carbon emission and Global Issues:

Nature of environmental problems, intensity, general causes, and impacts of global, regional and local environmental problems, population explosion and carbon emission trends, carbon emission and global warming, carbon emission and climate change, ozone layer depletion, acid rain, loss of biodiversity, environmental degradation, pollution of air, water and soil, mitigation and remedial measures.

Unit III: Carbon Sequestrations:

Carbon sequestration concept, introduction, types of carbon sequestration, terrestrial carbon sequestration, geological sequestration, ocean sequestration, National Energy Technology Laboratory (NETL), Concept of carbon sequestration in plants, animals and soil, carbon sequestration in food chain, food web, carbon storage in plant and soil, carbon sequestration as greenhouse mitigation policy, role of trees, vegetation and forest in carbon sequestration, monitoring and measurement of wood and soil carbon.

Unit IV: Carbon credits:

Pattern of energy use, energy technologies and environmental impacts, need of carbon trading, Concept and theme of Kyoto protocol, role of international agencies, obligation on nations for carbon emission reduction, Kyoto declaration, Economics of carbon sequestration, legal and institutional issues, carbon credit evaluation mechanics, carbon credit-trading and tax.

Unit V: Energy Conservation and Carbon Trading:

Domestic energy needs, social energy utilization pattern, energy use and carbon emission in industrial and commercial sectors, energy utilization pattern of global, national and local levels, methods for the conservation of energy, Concept of carbon trading, Carbon marketing potential, carbon credits and agriculture, Scope of carbon trading in India.

Current development in the subject.

Course Outcome

Students should be able to:

1. Identify the concepts of ecological footprint
2. Interpret carbon capturing for sustainable future
3. Apply carbon sequestration as green house mitigation policy
4. Create own consultancies

References

1. IPCC (Intergovernmental Panel on Climate Change) 2006. Guidelines for national greenhouse gas inventories. Vol. 4, Agriculture, Forestry and other land use (AFLOLU). Institute for Global Environmental strategies, Hayama, Japan.
2. http://www.carbonfootprint.com
3. http://www.footprintnetwork.org/en/index.php/GFN/page/carbon_footprint
4. http://www.eoearth.org/article/Carbon_footprint
5. Arnaud Brohé, Nick Eyre and Nicholas Howarth Carbon Markets An International Business Guide,
6. Brian J McPherson; E T Sundquist, 2009. A book on Carbon sequestration and its role in global carbon cycle, Washington, DC: American Geophysical Union ; published under the aegis of the AGU Books Board.
7. http://envfor.nic.in/cc/cdm/publications.htm
8. S.P. Sukhatme, Solar energy McGrawhill Publication.
9. S. H. Pawar, C. D. Lokhande, R. N. Patil, 1988. Solar energy and Rural Development, Shivaji University, Kolhapur.
10. Chawla, O.P. Advances in Biogas Technology, ICAR Pub. New Delhi.
11. Rai, G.D. Non-renewable Energy Resources, Khanna Pub., New Delhi.

LC: ENV 541: Lab Course – IX

(Based on CC Env. 501 & 502)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. Determination pH & Electrical Conductance of Municipal Solid Waste.
2. Determination of Total water soluble solids of Municipal Solid Waste.
3. Determination of Moisture content of Municipal Solid Waste.
4. Determination of Loss on Ignition of municipal Solid Waste.
5. Determination of Organic Carbon from Municipal Solid waste.
6. Determination of Total Kjeldahl Nitrogen from Municipal Solid waste.
7. Determination of Total Phosphorous in Municipal Solid waste.
8. Determination of Potassium of Municipal Solid Waste.
9. To study the percentage composition of degradable and non degradable material from solid waste.
10. To study the percentage of potential recycling material from municipal solid waste.
11. To study and list the laboratory safety and industrial safety principles and practices.
12. To study the impact of solid hazardous waste (toxic substance) on germination and growth of crop plants.
13. To study the conventional signs and symbols used in hazardous waste study.
14. Geological investigation and identification of landfill sites for solid waste management.
15. To study the leachable calcium and magnesium content from vermicompost prepared from municipal solid waste.
16. Developing appropriate microbial consortium for land applied effluents. (Bioremediation)
17. Methods for the Determination of Hazardous Characteristics of Wastes.
18. Determination of Ignitability of Hazardous waste by Setflash closed Cup Method/ Pen sky closed cup method.
19. Marginal information of toposheet and indexing of toposheet.
20. To study the conventional signs and symbols from toposheet
21. Interpretation of toposheet for specific objects.
22. To study the principle and application of: a)Pocket Stereoscopes, b) Mirror stereoscope, c) Parallax Bar.
23. Stereoscopic vision test by using pocket stereoscope.
24. Determination of scale of aerial photograph and satellite image.
25. Identification of features on vertical aerial photograph.
26. Land use and land cover study / mapping of objects from aerial photograph.
27. Orientation of sterio- model under mirror stereoscope and detection of objects from steriopairs.
28. Determination of GPS coordinates of selected area and confirmation of objects from satellite image /toposheet / ground truthing of objects.
29. GIS software's browsing of satellite data.
30. To study the land use and land cover visually by using satellite images tone texture and pattern etc.
31. Digital image processing- image registration , rectification and image enhancement.
32. Image interpretation- unsupervised and supervised classification.

LC: ENV 542: Lab Course – IX

(Based on CC Env. 503, Env. 521-A, & Env. 521-B)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1. To study the common test animals of toxicity assessment and their acclimatization.
2. To study he dose response curve of toxicant with respect to different concentration and exposure time in same size test animals.
3. To study the dose response curve of toxicants with respect to different body size and exposure time in same concentration of toxicant.
4. Determination of lethal dose (LD)of toxicant (pesticides / heavy metals compounds) in test animal (Channa fish) in 24 hours.
5. Determination of LC_{10} LC_{50} & LC_{90} of toxicant (pesticide/heavy metal compound) in aquatic animal (fish/snail) for 24, 48, 72 & 96 hours exposure.
6. Determination of lethal dose of toxicant (pesticide / heavy metals) in test animal from LC_{50} values.
7. Determination of safe concentration of toxicant (pesticide/heavy metals) in test animal from LC_{50} values.
8. Toxicity assessment of solid/powdered form of toxicant in solid-solid mixture and determination of LC_{50} value for 24 hours in insects.
9. To study the effect of acute exposure of toxicant on oxygen consumption in aquatic test animal.
10. To study the chronic effect of toxicant on carbohydrate/ protein content of tissue in test animal.
11. Qualitative detection of pesticides in tissue of pesticide exposed test animal by TLC method.
12. To study the bioaccumulation of toxicant in test species (plant/animal).
13. To study the total carbon content present in plant biomass.
14. To study the calorific value of plant biomass by titrometric method/ bomb calorimetric method.
15. Study of carbon footprint of product.
16. Determination of rate of carbon fixation in aquatic ecosystem by phytoplankton.
17. Immobilization of cultured bacterial sample.
18. Measurement of carbon content from various soil samples by ignition method.
19. Determination of various parameters from prepared compost and comparison with standards.
20. Determination of air pollution index.
21. Determination of soil pollution index.
22. Determination of urban infrastructure index.
23. Determination of water quality index.
24. Determination of Environmental pollution index (EPI).
25. Determination of life quality index.
26. Determination of Comprehensive environmental pollution index (CEPI).

LC: ENV 543: Lab Course – XI
Project / Dissertation Part-I

[Core course with **08** credits]

Total Marks -100

1. Project work -70 Marks (External Assessment)- Survey, Environmental Audit, Field Visit, Emergency Management Plan, EIA, EMP etc.
2. Project work -20 Marks (Internal Assessment)
3. Tour Report - 10 Marks (Internal Assessment) – Visit to Industry / Eco-Village etc.

Note: I) the project work is to be allotted after the end of the IInd semester.

Semester – III

SC (Env-522:- Climate Change and Global Environmental Issue)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Concepts of climate change, Strategies of green house warming.
2. Global Environmental problem, developmental priorities in India.
3. Environmental movements and controversies, Reclamation of Alkaline and saline soil.
4. Natural Hazards & Man made hazards, Control Measures.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit – I: Climate Change:-

Climate change- introduction, concept and phenomenon; Climate change and its impact on agriculture, its impact on agricultural biodiversity, climate change and emerging of new kinds of diseases and epidemics; Human health problems , climate change and its impact on hydrological cycle - rainfall, icefall, surface water resources; Climate change and oceanic environment; IPCC reports ; Energy policies in Asia in light of climate change; Strategies to handle green house warming - Chine's stand; Reply of Malaysia to Global Climate change; India's action plan on climate change.

Unit – II: Global and local environmental issues:

Global environmental problems- global warming concept and considerations; green house emission rate; ozone layer depletion; Cycles of global environment change; Scientific evidences of greenhouse effect or to global warming ; Effect of Global warming : atmospheric gases and their impacts on ionosphere, Meteorology and dispersion of atmospheric gases, Green house effects current status, polar ice caps and snow melting due to temperature fluctuation, Health and hygiene considerations due to global warming; Global warming and other related environmental problems with respect to aquaculture,

Unit – III : Environmental and developmental priorities in India :

Developmental priorities in India, Pre independence and post independence development, Industrialization, Green revolution, Urbanization, developmental priorities vs. environmental priorities, resource depletion and degradation due to improper priorities such as water, soil, forest etc in India.

Unit – IV : Global environmental Movements and controversies:

Environmental movements - Environmental movements and peoples responses; Green peace, world watch Institute, wetland international etc. Indian environmental movements and initiatives Chipko, Apico, Narmada Bachoao Andolan, Save western Ghats, Environmental Controversies : social political and economic issues in the controversies, Narmada Project, Almatti dam, Sarda Sarovar project, Tehri dam, Koyna dam, MIC gas tragedy, Chernobyl tragedy, Mahtura Refinery case, Silent valley, Rehabilitation and settlement issues, government policies and social awareness for the protection of environment. Reclamation of alkaline and saline soils, Interstate river water disputes.

Unit – V : Natural Man made Hazards: :

Flooding, Nature and frequency of flooding, Impacts of flood hazard; urbanization and flooding; flood mitigation methods; land slide – causes and consequences; human land use and landslides; prevention and control of land sliding, Coastal hazards; tropical elegance and tsunamis; coastal erosion; sea level changes and its impact on coastal areas. Earthquakes; causes, intensity and magnitude of earthquakes; causes; geographic distribution of earthquake zones, seismic waves, travel time and location of epicenter; natures of destruction; ground subsidence; protection from earthquake hazards; volcanism; nature and causes of volcanism, volcanism and climate. Social and economic impact of natural disasters; Manmade Hazards :- Industrial accidents; causes and effects of hazardous waste, chemical waste and their disposal and control, oil spills-causes, impacts and control, manmade hazards; forest fire, industrial fires and control; environmental degradation due to wars.

Current development in the subject

Course Outcome

Students should be able to:

1. Locate global environmental issues
2. Compare climatic change effects on natural environmental components
3. Correlate developmental priorities in India
4. Evaluate controversial issue s and its mitigations

References

1. Coastal Zone Management by Dr. Ramakrishnan Korakandy.
2. Environment Security and Tourism Development in South Asia by V.C. Pandey
3. Environment and its Global Implications by Gopal Bhargava.
4. Indian Vistas of Environment by Chittabrata Palit and Mahua Sarkar.
5. The Immanent Disaster A vision on Climate change by Sampooran Singh
6. Natural Resources of Himalaya by K.S.Gupta/
7. Fly Ash Amendment and plant Growth by Dr. S.M. Mohan
8. Environmental Education by Archana Tomar
9. Disaster management by S.Narayan
10. Biodiversity and Ecosystem Conservation by Ashish Dutta
11. Corporate governance for sustainable environment by Ramesh Chandra and Ritu Aneja
12. Global warming and climate changes transparency and accountability edt by Gopal Bhargava.
13. Energy and environment in india by K.C.Gupta

Semester – IV

CC (Env-504:- Risk Assessment and Disaster Management)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Concept of Disaster and its types.
2. Concept of Disaster Management, Role & Responsibility, of Disaster Management, Rehabilitation & Relief in Disaster Management & Risk Assessment Process.
3. Causes & Consequences of Industrial Disaster, Emergency strategies, Disaster Plan in Industrial.
4. Disaster Monitoring & Mitigations, Technological & Operational Frame Work.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

UNIT I : Risk Assessment :

Introduction and Concept of risk assessment, Components of risk assessments, risk assessments in disaster, risk assessment industrial disaster, vulnerability analysis and management, process of hazard management, on side emergency and off side emergency plan for industrial disaster management.

UNIT II : Hazards and Disasters:

Definition of hazard and disaster, classification of disasters, impacts and mitigation strategies for earthquake, tsunami, flood, drought, land slide and cyclones, indicators of disasters: physical indicators and biological indicators, national development and disaster, planning for disaster prevention, social and economic impacts of disaster

UNIT III : Disaster Management :

Concept of disaster management, disaster management cycle, disaster mediation, disaster preparedness and its components, community waste disaster management, role and responsibilities of disaster management tips, disaster leadership and co ordination , rehabilitation and relief in disaster preparedness, effects of disaster on specific groups(Children's, Women, Old age persons)

UNIT IV: Industrial Disaster Management:

Introduction to industrial disasters, Causes and consequences of industrial disasters, levels of disasters and alertness, phases of disaster, warning phase ; impact phase, rescue phase and relief phase, Emergency strategies on site emergency and offside emergency, disaster responses, essentials of disaster plans in industries.

UNIT V: Disaster Management Tools:

Disaster monitoring for data collection, mapping, and mitigation, Global positioning system, Global Information System, remote sensing and Aerial photography as tools for disaster management, Capabilities and limitations, government and non-governmental efforts, public awareness, need of disaster training and interdisciplinary approach, restoration management; disaster management in India, new culture of disaster management, technological and operational framework.

Current development in the subject.

Course Outcome

Students should able to:

1. Define the different types of disasters.
2. Describe risk assessment and disaster management process
3. Apply the knowledge for industrial disaster management
4. Plan for the disaster management.

References

1. Abbott, P.L., 2002, Natural Disasters, McGraw Hill, Boston.
2. Aggarwal, S.K., 2007, Disaster Management in Technology and culture, Arise Pub. & Dist., New Delhi.
3. Narayan, B., 2009, Disaster Management, APH Pub. Co., New Delhi.
4. Chakrabarty, U.K., 2007, Industrial Disaster Management and Emergency Response, Asian Books Pvt. Ltd., New Delhi.
5. Bose, B.C., 2007, Disaster Vulnerability and Management in
6. Global perspective, Rajat Pub., New Delhi.
7. Ghosh, G.K., 2006, Disaster Management Vol. I to VI, APH Pub. Co. New Delhi.
8. Singh, R.B., 1994, Space Technology for Disaster Monitoring and Mitigation in India, University of Tokyo.
9. Smith Keith, 1992, Environmental Hazards: Assessing risks and reducing disaster, Routledge, London.
10. Singh, R. B., 2006, Natural Hazards and Disaster Management-vulnerability and mitigation, Rawat Pub., Jaipur.
11. Mukesh Dhunna (2009): Disaster Management, Vayu Education of India, Ansari Road, Daryaganj, New Delhi – 110002.
12. Arun Kumar Talwar and Satish Juneja : Hazardous Materials and Disaster management, Commonwealth publishers, New Delhi – 110002.
13. S.R. Singh: Disaster Management, A.P.H. Publication Corporation, New Delhi – 110002.

Semester – IV

CC (Env-505:- EIA & Environmental Auditing)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Scope & Objectives of EIA, Skip Relation of EIA to Sustainable Development.
2. Various Components of EIA, Impact Interpretation & Analysis.
3. EIA Notification 2006 & Amendment, Public Participation in EIA.
4. Scope & Objectives of Environmental Audit, Submission of Environmental Audit Report to MoEFCC.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I: Introduction:

Concept of EIA, Scope and Objectives of EIA, Nexus between development and environment, origin and development of EIA. Measurement of impact-physical, social, economical, natural; concept of significant effect; short term versus long term effect; skip relation of EIA to sustainable development.

Unit II: Environmental impact Assessment Methods:

Screening process, TOR, data collection, protocol for evaluation of impacts, pollution load calculation, methods of impact analysis: - Impact identification prediction, evaluation monitoring and mitigation measures, Public participation in environmental decision making, Assessment of various categories of EIA-rapid, comprehensive, regional and strategic EIA. Various components of EIA, Impact interpretation, various impact analysis methods-checklist, overly, matrix, and Adhoc methods.

Unit III: Assessment of Impact

Overview of EIA notification,2006 and amendments, Evaluation of proposed actions and determination of impact importance, Development of value functions and scoping of EIA methodologies, preparation and writing of EIA/EIS, Review of procedure, practices and guidelines for EIA in India. Role of EIS in EIA –Baseline study, risk assessment, risk management, mitigation measures and comparison of alternatives Impact analysis with respect to air and water quality, noise, energy, vegetation and wild life and social and economic issues, Public participation in EIA.

Unit IV: Case Studies of EIA

EMP for a particular sector like, urbanization, mining, industrial [cement, Pharmaceutical, distillery etc].Thermal power plants, hydropower, Road and highway projects etc.

Unit V : Environmental Audit

Introduction ; Scope , Applicability and Objectives of Environmental Audit; Notification and Guidelines for Environmental Audit; Procedure of Environmental auditing (Water, Raw Materials and Energy balance; Hazardous waste Audit, Safety Audit); Designing and implementation of audit tools; pre audit activities; on site activities; post audit activities; Environmental statement; benefits of environmental audit; EA scenario in India – submission of Environmental Audit report in MOEF format – form VB; Environmental performance evaluation;

Current development in the subject.

Course Outcome

Students should be able to:

1. Define scope and objectives of EIA , nexus between development and environment, skip relation of EIA to sustainable development
2. Identify social, economical and environmental impact for human welfare
3. Evaluate EIA notification 2006 and amendments, public participation in EIA
4. Assess screening process in EIA, TOR, protocols for evaluation of impacts and impact analysis.
5. Explain environmental audits, hazardous waste audit and safety audit

References

1. Environmental Impact Assessment: A. Eillpin.
2. Environmental Impact Assessment and Management: H. Kumar (1998).
3. Environmental Impact Assessment of Tehri Dam: V. Govardhan.
4. Practical guide to Environmental Impact Assessment: Belly Bowers and Marriott (1977).
5. Environmental Impact Assessment: A. K. Shrivastava APH Publication 2003.
6. Law of Intellectual Property: Dr. S. R. Mysani Asia Law House (2nd Edition) Law Book Sellers, Publishers and Distributors Hyderabad.
7. Environmental Impact Assessment, L. W. Canter, McGraw Hill publication, New Delhi.
8. Proceedings Indo-US workshop on environment impact analysis and assessment (1980) NEERI, Nagpur.
9. Environment & Social impact assessment, Vlcany, F., Bronsetin DA (1995), John Wiley & Sons, New York.
10. EIA – A Biography. B. D. Clark, B. D. Bissel, P. Watheam.
11. Second world congress on engineering and environment 1985, Institution of engineers.

Semester – III

CC (Env-523-A: - Advance Technologies and CDM)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Concepts of Advance Technologies, AOP, VOC etc.
2. Nanotechnology as a tool for sustainability, Nano particle Characterization.
3. Concept of CDM, issues related to clean development mechanism.
4. National CDM, technology and Climate Change.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I: Introduction to Advance Technologies:

Characterization of effluent, Introduction of AOP(Advance Oxidation Processes), Fundamental of AOP for waste water treatment, UV/0_3 processes, ozonation, fenton processes, Ultrasound processes, application of AOP for VOC reduction and odor treatment, Sonochemistry, photochemistry, photochemical processes for water and waste water treatment,

Unit II: Environmental Nanotechnology

Background of nanotechnology, partial size an surface area, converging science and technology, nanotechnology as a tool for sustainability, health, safety at environmental issues ; Characterization of nano materials, AFM , STM,SEM,TEM,XRD,ESCA,IR and raman UV-DSR of nano materials for structural and chemical nature.

Unit III: Clean Energy Technology

Renewable energy projects and Clean Development Mechanism, biomass energy based systems, Clean Development Mechanism benefits , first small scale project registered in India , challenges of Clean Development Mechanism, reclamation of oil polluted soil, metal pollutant recovery from polluted soil.

Unit IV: Clean Development Mechanism

Clean Development Mechanism concept, Introduction, Need of Clean Development Mechanism , Zero pollution and discharge, history of Clean Development Mechanism , Issues related to Clean Development Mechanism, basic principles and functions of Clean Development Mechanism, present status and proposal of development of Clean Development Mechanism.

Unit V : Clean Development Mechanism and climate change

CDM Gold Standards', Organization of CDM, Green house gases emissions, carbon sequestration under Clean Development Mechanism, Clean Development Mechanism and carbon trading in India, trading and project based mechanism, developing a national Clean Development Mechanism strategy. Clean Development Technology and climate change

Current development in the subject.

Course Outcome

Students should be able to:

1. Define the advanced technologies and CDM
2. summarizes nanotechnology for optimization of treatment plant
3. apply CDM mechanism as a strategy plan
4. create own consultancies

References

1. Clean development mechanism (CDM) and carbon trading in India – Jitendra Kumar singh.
2. Bio-energy and CDM – B.Schlamadinger, J. Jurgens jaoanneum research, Elisabathstasse.
3. Carbon sequestration option under the CDM-FAN of UN
4. CDM gold standards – Wikipedia,free encyclopedia.mnt
5. CDM & wind energy-Dec 2009 WWE A-charles-de-Gautlestr 553113 bonn Germany
6. GHeG omissions trading and project based mechani – preceding-organization for economic co-operation and development, concerted action on tradable emissions permits.
7. Michael L. McKinney and Robert M. Schoch, 2003, Environmental Science-systems and solutions, Jones and Bartlett Pub., Boston.
8. Peavy, H.S., 1985, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
9. Peavy, H.S., Rowe D. R. and Tchobanoglous G., 1985, Environmental Engineering, Tata McGraw-Hill International Ed., New York.
10. Purohit S.S. and Ranjan R., 2003, Ecology, Environment and Pollution, Agrobios, Jodhpur.
11. Raju B.S.N., 1997, Fundamentals of Air Pollution, Oxford & IBH Pub. Co.Pvt.Ltd., New Delhi.
12. Rao M.N. and Rao H.V.N. 1989, Air Pollution, Tata McGraw-Hill Pub. Co.Ltd., New Delhi.
13. Rao C.S., 1991, Environmental Pollution Control Engineering, Willey Eastern Ltd., New Delhi.
14. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
15. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
16. Michael L. McKinney and Robert M. Schoch, 2003, Environmental Science-systems and solutions, Jones and Bartlett Pub., Boston.
17. Peavy, H.S., 1985, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
18. Peavy, H.S., Rowe D. R. and Tchobanoglous G., 1985, Environmental Engineering, Tata McGraw-Hill International Ed., New York.
19. Purohit S.S. and Ranjan R., 2003, Ecology, Environment and Pollution, Agrobios, Jodhpur.
20. Raju B.S.N., 1997, Fundamentals of Air Pollution, Oxford & IBH Pub. Co.Pvt.Ltd., New Delhi.
21. Rao M.N. and Rao H.V.N. 1989, Air Pollution, Tata McGraw-Hill Pub. Co.Ltd., New Delhi.
22. Rao C.S., 1991, Environmental Pollution Control Engineering, Willey Eastern Ltd., New Delhi.
23. Pandey G.N. and Carney G.C., 2002, Environmental Engineering, Tata McGraw-Hill Pub. Co., New Delhi.
24. Meenakshi P., 2005, Elements of Environmental Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
25. A. D. Bhide and B. B. Sunderson, Solid Waste Management in developed Countries, INSDOC, New Delhi (1983).
26. Sinha R. K., Sinha A. K., Saxena V. S., A book on Waste Management INA, Shri Publishers, Jaipur (2000).
27. Environmental applications of nanomaterials-synthesis, Sorbents and sensors, edited by Glen E Fryxell and Guozhong Cao, Workdscibooks, UK
28. Environmental nanotechnology, Mark wisener, Jeo, Yues Bolteru,2007, McGraw Hill.
29. Simon parsons, Advanced oxidation processes for water and wastewater treatment, IWA Publishing,2004 Thomas oppenlander, photochemical Purification of water and Air: Advanced Oxidation processes (AOPS) Principles, Reaction Mechanisms, Reactor Concepts. Wiley-VCH Publishing, Published by 2003.
30. Vincenzo Belgiorono, Vincenzo Naddeo and Luigi, Rizzo, Water,Wastewate and soil treatment by Advanced oxidation processes (AOP), Lulu enterprises, 2011.
31. Harold, J.Ratson, Odor and VOC control handbook, New york, Mcgraw-hill,1998.

Semester – III

SC (Env-523-B: - Ground Water Engineering and Watershed Management)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. History and Characteristics of ground water, ground water level fluctuation & Environmental influence.
2. Advanced methods in Well hydraulics, waste water recharge for reuse.
3. Status of Groundwater in India
4. Concept of watershed & management short term and long term strategies planning.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Test	:-	20 Marks
Tutorials	:-	1 hr/ week	Teacher Assessment	:-	30 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	50 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit – I : Introduction

Ground water utilization & historical background, Characteristic of ground water, Global distribution of water, Role of groundwater in water resources system and their management, groundwater column, aquifers, classification of aquifers, Hydro geological cycle, water level fluctuations, Groundwater balance, ground water level fluctuations & environmental influence.

Unit – II : OCCURRENCE AND MOVEMENT OF GROUND WATER

Origin & age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration & saturation, aquifers and their characteristics/classification, Darcy's Law, Hydraulic conductivity, Aquifer transmissivity and storativity, Dupuit assumptions Storage coefficient - Specific yield Heterogeneity and Anisotropy, Direct and indirect methods for estimation of aquifer parameters, Governing equation for flow through porous medium - Steady and unsteady state flow - Initial and boundary conditions, solution of flow equations.

Unit-III : ADVANCED METHODS IN WELL HYDRAULICS

Steady and unsteady flow to a well in a confined and unconfined aquifer - Partially penetrating wells - Wells in a leaky confined aquifer - Multiple well systems - Wells near aquifer boundaries - Hydraulics of recharge wells, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield, Concept & methods of artificial ground water recharge mounds & induced recharge, wastewater recharge for reuse, water spreading.

Unit-IV : Introduction and Basic Concepts:

Concept of watershed, Introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making, Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning.

Unit-V: Integrated Watershed Management:

Introduction to integrated approach, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system, Standard modeling approaches and classifications, System concept for watershed modeling, Overall description of different hydrologic processes, modeling of rainfall-runoff process, Subsurface flows and groundwater flow, Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies, Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management, Drought assessment and classification, drought analysis techniques, drought mitigation planning.

Current development in the subject.

Course Outcome

Students should be able to:

1. Describe current status of ground water with respective environmental influence
2. Apply knowledge in wells hydraulic mechanisms
3. Analyze ground water quality
4. Create models of integrated water sheds & Apply GIS and Remote Sensing in watershed management

References

1. Bear J., Hydraulics of Groundwater, McGrow-Hill International, 1979.
2. Todd D.K., Ground Water Hydrology, John Wiley and Sons, 2000.
3. Driscoll, F., Groundwater and Wells, St. Paul, Minnesota, II Ed., 1986.
4. Raghunath H.M., Ground Water Hydrology, Wiley Eastern Ltd., Second reprint, 2000.
5. Willis, R. and W.W.G. Yeh, Groundwater Systems Planning and Management, Prentice-Hall, 1987.
6. Bear J., Dynamics of fluids in porous media, American Elsevier publishing co. 1972.
7. C. Walton, Groundwater Resources Evaluation, McGraw Hill, 1970.
8. O.D.L. Strack, Groundwater Mechanics, Prentice Hall, 1989.
9. S.P. Garg, Groundwater and Tube Wells, Oxford & IBH Publishing Co., 1990.
10. D. K. Todd and L. F. Mays, "Groundwater Hydrology", John Wiley and sons.
11. K. R. Karanth, "Hydrogeology", TataMcGraw Hill Publishing Company.
12. S. Ramakrishnan, "Ground water", S. Ramakrishnan.
13. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.
14. American Socy. of Civil Engr., Watershed Management, American Soc. of Civil Engineers, New York, 1975.
15. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
16. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992.
17. Murty, J.V.S. “Watershed Management”, New Age Intl., New Delhi 1998.
18. Murthy, J.V.S., Watershed Management in India, Wiley Eastern, New Delhi, 1994 .
19. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad.
20. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.
21. Das M.M. Watershed Management, Prentice Hall India Learning Pvt. Lit, 2012
22. R.S. Kurothe, A. k. Vishwakarma, Gopal Kumar. Watershed Management An Encyclopedia, Biotech Books Publisher.
23. Reddy Yvr, Watershed Management, Agrotech Publishing Academy.
24. Kenneth N. Brooks, Peter F. Flolliott, Joseph A. Magner, Hydrology and the management of watershed

LC: ENV 545: Lab Course – XII
(Based on CC Env. 504, ENV-505, ENV-523 –A & B)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
			Test	:-	10 Marks
Assignment / field work/ outreach activities	:-	2 hr/week	Teacher Assignment	:-	15 Marks
			Sem-End Examination	:-	25 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

1) To study the stream ordering from toposheet of selected area
2) Determination of catchment area of river basin by considering pour point.
3) Determination of water storage capacity of independent house in roof top rain water harvesting.
4) Basic rain water collection calculations in roof top rain water harvesting and preparation of rain water spreadsheet.
5) To study the preparedness of disaster management.
6) Preparation of EIA statement for development activities.
7) Preparation of Environmental Audit Report of any one industry.
8) Preparation of TOR (Turn of Reference) for EIA in any two industries.
9) Determination of Alpha, Beta and Gama radiation from various sites.
10) To determine latitude and longitude by using GPS survey meter.
11) Determination of Uranium content in Ground water by using LED Fluorimeter.
12) To determine the total hardness (Ca^{++} and $Mg^{++)}$ of provided ground water sample.
13) To determine the Total Alkalinity of provided ground water sample.
14) To identify the rock types from sampling sites.
15) To determine the Total Dissolved Solids from provided ground water sample.
16) To determine the Electrical Conductivity from provided ground water sample.
17) To determine the Sulphate by using Spectrophotometer from ground water sample.
18) To determine the Nitrate by using Spectrophotometer from ground water sample.
19) To study confined aquifer.
20) To study unconfined aquifer.
21) To study the Hydrological properties of Rock.
22) To study the well inventory.
23) To determine the Chloride from provided ground water sample.
24) To study the onsite and offsite emergency plans in disaster management.
25) To study and list the laboratory safety measure
26) To study the personal protective equipments in industrial safety.

LC: ENV 546: Lab Course – XIII
Field Work and In-plant Training

Lab Course	:-	4 hr/week
Assignment / field work/ outreach activities	:-	2 hr/week
Total Credit	:-	02

[Core course with 02 credits]

Total Marks: 50

In-Plant training -30 Marks (External Assessment)

In-Plant training -05 Marks (Internal Assessment)

Field work - 15 Marks (Internal Assessment)

(Garden Development and Maintenance / Lab. Cleaning & Maintenance, Chemical Preparation etc.)

Note: - In-Plant Training only for 15 Days in Industries/ Consultancy Lab/ Pollution Boards/ ETP, STP/ Research Institute/ R&D, NGO's/ Government Labs/ Sugar Factory/ etc.

LC: ENV 547: Lab Course – XIV
Project / Dissertation Part-II

Lab Course	:-	4 hr/week
Assignment / field work/ outreach activities	:-	2 hr/week
Total Credit	:-	**08**

[Core course with **08** credits]

Total Marks -200

1. **Project work -100 Marks (External Assessment)- Lab analysis,data analysis statistics applications, project writing, treatability study, Model designing, Project designing etc.**
2. **Project work -50 Marks (Internal Assessment)**
3. **Tour Report - 50 Marks (External Assessment) – Long Tour Compulsory -Visit to Industries, R&D / STP/ETP/Forest visit /Marine Biodiversity / Research Institute etc.**

Note: I) The project work is to be allotted after the end of the IInd semester.

Project work on following areas will be preferably encouraged;

1. Non-conventional energy,
2. Energy issues,
3. Watershed Management,
4. Monitoring of Air, Water and Soil Pollution,
5. Pesticide Pollution,
6. Pollution control technologies,
7. Alternative technologies,
8. Pollution impact studies,
9. Health and sanitation studies,
10. Soil salinity and its reclamation,
11. Phytoremediation and bioremedi0ation,
12. Recent advanced research areas in Environmental Science.
13. Treatability studies of Industrial waste effluents.
14. GIS,GPS and RS, Toposheet
15. Biodiversity
16. Preparation of EIA
17. Environment, Health & Safety.