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

Department of Environmental Science

Structure and Curriculum

For

M.Sc. Environmental Science
of
College and University Department
(Choice Based Credit System)
With
OBE Pattern

(Effective from the Academic year2021-22)

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Course Structure

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

From Academic Year 2021-2022

106 credits against 2650 marks.

	M.Sc. I year (Semester- I)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
COM	IC-001	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	Physical and chemical Aspects of Environment	04	04	100
CC	ENV-403	Techniques in Environment and Analysis	04	04	100
EC	ENV-421A	Wildlife Conservation & Management	04	04	100
EC	ENV-421B	Environmental Metrology &Climate Change	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
ELC	ENV-444A	Lab Course-IV	04	02	50
ELC	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	Application of 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
ELC	ENV-448A	Lab Course -VIII	04	02	50
ELC	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	Solid Waste Management	04	04	100
CC	ENV-502	Ecological Footprint & Carbon Sequestration	04	04	100
CC	ENV-503	Advance Technology & CDM	04	04	100
EC	ENV-521A	Mooc's Course from SWAYAM Platform	04	04	100
EC	ENV-521B	Environmental Toxicology and Biodiversity Assessment	04	04	100
SC	ENV-522	Global Environmental Crises & Climate Change	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	04	02	50
LC	ENV-544	Lab Course- XII	04	02	50
Total Credits for Semester – III= 28 (Theory:20 ;Lab:08) (With One Elective Course)					
	M.Sc. II Year (Semester-IV)				
Course	**Course Code**	**Paper Titles**	**Hrs/ week**	**Credits**	**Marks**
CC	ENV-504	RS & GIS Application in Environment	04	04	100
CC	ENV-505	EIA & Environmental Auditing	04	04	100
CC	ENV-506	Sustainable Urban & Rural Developmental Planning	04	04	100
EC	ENV-523A	Mooc's Course from SWAYAM Platform	04	04	100
EC	ENV-523B	Ground Water Engineering and Watershed Management	04	04	100
LC	ENV-545	Lab Course -XIII	04	02	50
LC	ENV-546	Lab Course-VIV	04	02	50
LC	ENV-547	Project + Internship + Field visit / Tour + Review Writing + Research Proposal writing,	08	04	100
Total Credits for Semester –IV: 24 (Theory:16 ;Lab:08) (With One Elective Course)					

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

Introduction:

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

Eligibility conditions:

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

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

Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. Admission will be done on the basis of merit in their degree score or Common Entrance Test (CET) and performance of students at their qualifying graduate level examination. The weightage of 1% will be given to the candidates who offered Environmental Science as one of the optional subjects at the B.Sc. level for seeking the admission to the M.Sc. Environmental Science. Once the student is admitted he / she will be promoted to the 2^{d} year (3rd semester) if he / she qualify all courses lst semester and 50 % of theory courses of IInd 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 course implementing institute/ department, however he / she should not exceed more than twice the duration of the course from the date of first registration. The admission of the concern student will be automatically cancelled if he / she fail 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 106 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 28 credits with 700 marks and fourth semester is of 24 credits with 600 marks. Paper No ENV-522 of 4 Credits of 100 marks fromIIIrd semester will be a **Service Course** which can be opt by the students from other department / institutions.

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

1.	**Core Courses**	**:- 44 credits**
2.	**Elective Courses**	**:- 16 credits**
3.	**Foundation Course**	**:- 04 credits**
4.	**Service Course**	**:- 04 credits**
5.	**Lab Courses**	**:-24 credits**
6.	**Elective Lab Course**	**:- 08 credits**
7.	**RM Courses**	**:- 04 credits**
8.	**COM Course**	**:- 02 credits**
	Total Credits	**:- 106 credits**

Above credits includes the credits for Research Methodology /Research Project /in-plant training etc. in the following manner ,04 credits-RMC and 3 credits for Project dissertation,In-plant training and field work etc, with a total of 7credits devoted for research orient activities.

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. **Elective Lab Course (E L C)** :It includes all laboratory assignments related to elective theory courses.
7. **Research Methodology (RM):** This course includes research related components to understand basics in the research and develop the research skill.
8. **Common Course (COM) :** This course is introduced to learn the Great Constitution of India.
9. **Bridge Course in EnvironmentalScience**: This course is designed to provide some important concept's introduction as the base to science graduates, who have not studied the environmental science subject at graduate level. This course is being implemented at the beginning of M.Sc. Environmental Science 1st semester and will be used for **identification** of slow and fast learner student.

- 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 result of examination conducted of 'Bridge Course in Environmental Science' will be used to identify the slow and fast learner students, which is an integral part of OBE pattern.

- The student will have to register the service course of his interest after the start ofIIIrdsemester in the concerned department on official registration form and is to be completed in this semester.

- 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, theprofessionals 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 106 credits for the award of M.Sc. (Environmental Science) degree.
- Out of 106 credits, students will have to earn the credits from Core courses with 44 credits, foundation course worth 04 credits, elective courses worth 16 credits, laboratory courses worth 32 credits (24 credits for core Lab course and 8 credits for Elective Lab course), research methodology 4 credits, service course 04 credits and 02 credits from the compulsory course 'Constitution of India'.

Credit-to- contact hour Mapping:

One contact hour per week is assigned 01 credit for theory and 0.5 credits for laboratory courses/ research project. Thus a 04 - credit theory course corresponds to 04 contact hours per week and same analogy will be applicable for laboratory courses / research project, containing 04 contact hours per week for 02 credits practical course. Overall, one credit equal to 15 hours for theory and 30 hours for practical.

Note:

- Tutorial, assignments and seminar presentation are integral components of all theorycourses. Tutorials consist of conceptual / questions based on the respective theory courses in the semester covering all units of paper.
- Each course / paper should be taught about 56 contact hours in one semester.
- Teaching duration for LAB COURSES from first to fourth semesters should be of 04 hoursper week per batch.

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.

Pattern:

The 80:20 patterns for external and internal assessment will be implemented with continuous assessment and there shall be combined passing for external and internal assessment.

Results Grievances

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

Evaluation Methods:

The assessment will be based on 80:20 ratios for external and internal pattern. In the continuous internal assessment (CIA) and semester end examination (SEE), there is combined passing.

Continuous Internal Assessment (CIA):

- For the theory paper of 100 marks: The Continuous Internal Assessment (CIA) of the students, containing 20 marks for two midterm tests (10 marks per test), 10 marks for two tutorials (05 marks per tutorial), 10 marks for one seminar (08 marks for giving seminar and 02 marks for submission of hard copy of seminar) and 10 marks for attendance and overall performance of the students. The marks secured out of 50 will be scale down to 20 as internal marks secured out of 20.
- For theory paper of 50 marks: The Continuous Internal Assessment (CIA) containing 20 marks for two midterm tests (10 marks per test), 10 marks for two tutorial (05 marks per tutorial), 10 marks for one seminar (08 marks for giving seminar and 02 marks for submission of hard copy of seminar) and 10 marks for attendance and overall performance of the student. The marks secured out of 50 will be scale down to 10 as internal marks secured out of 10.
- The first midterm exam will be taken after completion of 40 percent syllabus and second midterm exam will be taken after completion of 80 percent syllabus. The continuous internal assessment will be done by concern teacher, who is teaching that paper. The obtained score in Continuous Internal Assessment (CIA) will be considered as internal score.
- There will be 10 marks for Continuous Internal Assessment (CIA) of lab course / practical paper of 50 marks, containing 10 marks for one practical test, 10 marks for record book submission, 10 marks field work / assignments / viva on practical's and 10 marks for attendance, discipline & overall performance of student. The marks secured out of 40 will be scale down to 10 as internal marks secured out of 10.
- There will be combined passing for internal and external examination. The students have to earn minimum 40% marks for passing.

Semester End Examination (SEE):

- The semester end theory and practical examination will be conducted after completion teaching. The total marks shall be 100 for 4 credit theory courses, 50 marks for 02 credits theory course and 50 marks for 02 credits lab course / practical course. The semester end exam of 80 marks will be taken for 04 credits theory course and 40 marks for 02 credits theory course along with 40 marks lab course of 02 credits.
- Semester end examination (SEE) time table will be declared as per the university annual calendar. The paper setting and assessment of theory courses, laboratory courses and project dissertation will be done by external / appointed examiners.

A. Structure for theory course for Internal Assessment.

i) Theory paper of 100 marks

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

ii) Theory paper of 50 marks

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

B. Structure for lab course for Internal Assessment.

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

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

Every student will have to complete 106 credits to obtain the Masters degree in Environmental Science having practicals / laboratory work / field work / demonstration work etc., of which 102 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 of 4 credit will have two parts A and B with (20+60 = 80 Marks). Part A will be consisting of 10 questions having 1 mark each (multiple choice questions) , 05 questions of fill in the blanks / answer in single sentence for 05 marks and 05 marks for five match the pairs / true or false as compulsory short answer questions of total 20 marks and it should cover entire course curriculum. Part **A** will consist 20 Marks. Part **B** will consist 7 questions of which students will have to attempt any five questions each of 12 marks. The time duration of the paper will be 03 hours.
- The semester end examination of theory course of 2 credit will have two parts A and B with (10+ 30 = 40 Marks). Part A will be consisting of 05 questions having 1 mark each (multiple choice questions), 02 questions of fill in the blanks / answer in single sentence and 03 marks for 03 match the pairs / true or false as compulsory question of total 10 marks and it should cover entire course curriculum. Part A will consist 10 Marks. Part B will carry 5 questions of which students will have to attempt any three questions each of 10 marks. The time duration of the paper will be 02 hours.

  (Note: -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 40 marks each and of 4 hours duration. Student must perform at least three experiments from each lab course containing one major and two minor experiments. The major question of 12 marks and minor Question 10 marks and 04 marks for viva-voce exam and 04 marks for record book. The final practical examination will be conducted at the end of each semester along with the theory examination.
- Semester end examination for project dissertation will be carried out in the respective semester. The content, presentation, interaction and submission will be considered during project dissertation assessment.

  (**Note**: The project dissertation will be a part of lab course from fourth semester and it will be allotted at the beginning of first semester and assessed in fourth semester.)

- The students will have to complete one month In-plant training in Industry / Institution/NGO/ Laboratories / Municipal Corporation / Forest department / Pollution Board etc.
  (**Note** : Student will be deputed in summer vacation for in-plant training after IInd Semester Examination and student will have to submit in-plant training completion report with certificate to the department and it will be assess in final practical examination.)

- At the end of each semester the result will be forwarded to the Director of Examination Board by CAP chairman.

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 at heads of the examination of the course. The grade points and their equivalentrange of marks are shownin 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 have 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.

$$\mathbf{SGPA} = \frac{\boldsymbol{Sum\ (CourseCreditXNumberofGradePointsinconcernCourseGainedbytheStud\ nt)}}{\boldsymbol{Sum\ (CourseCredit)}}$$

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.

$$\mathbf{CGPA} = \frac{\boldsymbol{Sum\ (AllfourSemesterSGPA)}}{\boldsymbol{TotalNumberofSemester}}$$

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).

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			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	10 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	40 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, troubleshooting mechanism, field and laboratory problems.
3. Acquire knowledge of data collection, presentation of data, data analysis and presentation of samples.

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

2. "Research methodology-Text and cases with SPSS applications" by Gupta S.L. and Hitesh Gupta (2011); International book house Pvt.Ltd, new Delhi.
3. "Stastical Methods" by S.P.Gupta, Publisher S.Chand and Sons.
4. "Fundamentals of Research methodology and stastics" by Yogesh Kumar Singh , New Age International Publication, New Delhi.
5. "How SAGE has shaped Research methods A 40 years history" by John W Cresewell, University of Nebraska. Lincoln.
6. "The Essence of Research Methodology, A Concise Guide for Master & Ph.D. students in management science, by Jan Jonker &BartjanPennink, Springer.
7. Research Methodology in Environmental Science, (Dr.Satish Patil) 2019,International Publications, Kanpur (ISBN 978-93-87556-42-3).

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

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Continuous Internal Assessment by Teacher	:-	20 Marks
Tutorials	:-	1 hr/ week	Sem-End Examination	:-	80 Marks
Test	:-	1 hr/week			
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - **10+1**

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

Unit II: - **10+1**

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

Unit-III: - **10+1**

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

Unit-IV: **10+1**

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

Unit V: **10+1**

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

Current development in the subject.

Course Outcome

Students should able to:

1. Define human ecological systems and its functionality along with stability concept of ecosystem.
2. Describes and understand the earth environments balance.
3. Recognize ecological systems role in maintaining earth's environmental balance.
4. Examine the importance of balanced environment for survival of mankind on planet earth for long time.

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.
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8. Environmental Biology — P.D. Sharma, Rastogi Publication, Meerut.
9. Ecology and Environment - P.D. Sharma, Rastogi Publication, Meerut.
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11. Environmental Science —Enger, Smith, Smith, W.M.C. Brown company publishing
12. Practical Method in Ecology — R.K. Trivedi, P.K. Goel andTrisal., 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. New Delhi.
15. Concepts of Ecology (Fourth Edition)- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
16. Environment forest, ecology and man — Dixit R.K. Rastogi Publication, New Delhi.
17. Environment, energy, health planning for conservation — V. Vidyanath, Gyan Publishing House, New Delhi
18. Caring for the earth-A strategy for sustainable living; IUCN Publication.
19. Our planet, our health, our future: Human health and Rio Convention on biological diversity, change and desertification.
20. Report of the World Commission on Environment and Development; Our Common Future.
21. Environmental Earth Sciences Series Editor: James W. LaMoreaux.
22. Basic concepts: nature, ecology, environment.

Semester – I

CC (Env-402 :- Physical and Chemical Aspects of Environment)

(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 chemistry of Air, Water& Soil.
3. Understand green chemistry and its role in sustainable development.
4. Analysis process for Air, Water & Soil.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Continuous Internal Assessment by Teacher	:-	20 Marks
Tutorials	:-	1 hr/ week	Sem-End Examination	:-	80 Marks
Test	:-	1 hr/week			
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - Physical Aspects of Environmental Chemistry: 10+2

Interaction of thermodynamics with environment, Oxidation — Reduction reactions. Chemistry of Carbonate compounds, chemistry of hydrocarbons: introduction, types and hydrocarbons in environment, Radionuclide: introduction, radionuclides in environment and their properties, Chemical speciation - introduction, example: Mercury, Lead and Copper, arsenic. etc.

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

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

Unit-III: - Chemistry of Air 10+2

Classification of elements and periodicity in properties, chemistry of air, particles, Ions and radicals in the atmosphere and their role in atmospheric reactions, Chemistry of inorganic and organic particulate matter,.

Chemistry of heat trapping gases. Heat trapping gasses impact management, chemistry of acid rain, Impact of heat trapping gasses on global climate, Impact of global warming, chemistry of ozone depleting gases and their reactions , impacts of CFC on stratosphere , Chemistry of photochemical smog , Chemistry of Biogases

Unit —IV: - Chemistry of Water: 10+2

Chemistry of water, Solubility of compounds in water, Solubility of gases in water, Dissociating constant, Sample collection guidelines, Sample preservation , Sample order, Data collection and record keeping. Water quality parameters and standards,. Chemistry of cleaning agents, Soap, Detergents and bleaching agents, Chemistry of colloids, Gasoline and additives antiknock compounds, Lubricants and greases,

Unit — V: - Chemistry of soil: 10+2

Chemistry of soil, Composition of soil, soil quality parameters, trace minerals of soil, Factors affecting the soil quality, Adsorption of contaminant.

Biochemistry of Toxic chemicals in environment : Pesticides, Insecticides, Arsenic, Cadmium, Lead, Mercury, Carbon monoxide and Ozone, MIC and other carcinogens in Environment

Current development in the subject

Course Outcome

Students should able to:

1. Define physical and chemical aspects of environmental chemistry.
2. Apply the knowledge of chemistry to analyze air, water and soil quality.
3. Evaluate the level of contamination in environment.
4. Develop management strategies for industrial pollutants

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. Duffey, 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.
16. Emerging pollutants: origin, structure and properties- Francisco G Calvo-Flores, JoaguinIsac and Jose, Wiley VCH

Semester -I

CC (Env-403: -Techniques in Environment & Analysis)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to

1. To give students and understanding regarding environmental sampling, analysis and the various techniquesassociated.
2. To make students know the importance of proper sampling in environmental research.
3. Students are expected to have basic awareness on various separation techniques such as chromatography and analytical method titrimetry.
4. Apply knowledge of instruments in Environmental fields.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Continuous Internal Assessment by Teacher	:-	20 Marks
Tutorials	:-	1 hr/ week	Sem-End Examination	:-	80 Marks
Test	:-	1 hr/week			
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I: - Sampling and sample preparation: 10+2

Air, Water, Soil and sediment; Types of Samples-Grab samples, composite samples, Integrated samples, Sampling methods- Manual sampling, Automatic sampling, Sorbent sampling; Sampling types- Simple random sampling, Systematic random sampling, Stratified random sampling, Representative sampling, Geo-statistical (random field) sampling, Adaptive cluster sampling; Sample collection equipments.

Unit —II :- Analytical Techniques : 10+2

Theory, principles, instrumentation and Environmental application- pH, conductivity, Turbidity, Titrimetry, Colorimetry, Spectrophotometry, Atomic Absorption Spectroscopy (AAS, Flame emission spectrometry, Inductively coupled plasma Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Unit-III :- Separation Techniques : 10+2

Principles, Types and Environmental application- Sedimentation, Centrifugation, Electrophoresis, Chromatography-paper, TLC, Ion-exchange, Gas chromatography, HPLC.

Unit-IV:- Biological Analysis: 10+2

Collection, preservation and enumeration of planktons; Molecular techniques- polymerase chain reaction (PCR) florescence In-situ hybrization (Fish), Fatty Acid methyl Ester (FAME) analysis.

Unit-V Microbiological instruments andEquipments: 10+2

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

Current developments in the subject.

Course Outcome

On completion of this course, students should able to:

1. Comprehend the various sampling technique and its application.
2. Select sampling methods for making unbiased research.
3. Categorize analytical instruments used for environmental problems.
4. Students are expected to have a basic knowledge on various separation techniques such as chromatography and analytical methods like titrimetry.

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, Niraliprakashan, Mumbai.
10. Instrumental Methods of Analysis :G.W.Ewing.
11. Instrumental Analysis: gurdeep Chatwal (Himalaya Publishing House, New Delhi, (2000)
12. Allen J. Bard and Lafrry R. Faulkner (2001). Electrochemical Methods, 2nd Ed., John Wiley & Sons.
13. APHA — AWWA- WPCF. (2012). Standard methods for the examination of water and waste water. Washington, D.C.1
14. Bender, G.T., W.K Saunders. (1972). Chemical Instrumentation. A Laboratory Manual based on Clinical Chemistry.
15. Christian Gary, D. (2001). Analytical Chemistry, 5th Ed. John Wiley& Sons, Inc. NY.
16. De A.K. (1994). Environmental Chemistry. New Age International Ltd. New Delhi.
17. Eying G.W. (1985). Instrumental Methods of Chemical Analysis, 5th Ed., Mc-Graw Hill Book Company.
18. Radojecic M. and Bashkin V.N. (2007). Practical Environmental Analysis. RSC Publishing, Cambridge.
19. Skoog D.A., F.J. Holler and Nieman, (2003). Principles of Instrumental Methods, 5th Ed., Thomson Asia Pvt. Ltd., Singapore.
20. Vogel A.I.(1999). Textbook of Quantitative Chemical Analysis, 5th Ed., Addison Wesley Longman Singapore Ltd.
21. Willard, Merritt, Dean, and Settle, (1986). Instrumental Methods of Analysis, 7th Ed., C B S Publishers&Distributors.

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	Continuous Internal Assessment by Teacher	:-	20 Marks
Tutorials	:-	1 hr/ week	Sem-End Examination	:-	80 Marks
Test	:-	1 hr/week			
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 Siseases and Disorders, Arora dnBipulchakraborthy B.M.IBDC, Lucknow,2008.
4. Indian wildlife yearbook ,Arora B.M., Editor., AIZ and WV .Bareilly and central zoon authority, New Delhi 2002.
5. Rehabilitation in free living wild animals, Arora.B.M. AIZ and W,V.,Bareilly., 2007.
6. Reproduction in Wild Mammalia & Conservation, Arora B.M. AIZ and WV., 2002.
7. Wild Animals in Central India, Brander,A.A. Natraj Publisher, Dehradun.
8. The Temple Tiger. Corbett,Jim., Oxford University Press, New Delhi., 2007.
9. Handbook of Environment, Forest and Wildlife Protection Laws in India., justice Kuldip Singh, Natraj Publishers, Dehradun., 1998.
10. Biodiversity conservation in managed and protected areas, katwalf Banerjee, Agrobios, India., 2002.
11. The Ecology of wildlife Diseases. Peter J.Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestribeekand 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 & Climate Chang)

(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 monsoon and climatic considerations in Agriculture and Industrial sector.
3. Identify meteorological parameters to forecast the weather, scale of meteorology and to establish ambient and emission standards.
4. To assess different earths process, natural cycles and risk of geological hazards, like earth quake, floods, landslides, volcanism etc.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week	Continuous Internal Assessment by Teacher	:-	20 Marks
Tutorials	:-	1 hr/ week	Sem-End Examination	:-	80 Marks
Test	:-	1 hr/week			
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit — I :- Climatology: **10+2**

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

Unit— II :- Applied Climatology : **10+2**

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

Unit-III: - Climate of India: **10+2**

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

Unit— IV :- Meteorology: **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 —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.**

References

1. The Atmosphere : An Introduction to meteorology :- Frederic K. LutgenE.I.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 ofEcology :- E.P. Odum, Revised Edition 1995-96 Edition 2003.
7. A Manual of Air QualityMonitoring :- NEERJ Publication.
8. Environment, Energy, Health, Planning, for Conservation:-V. Vidyanath, Gyan Publication house, New Delhi.
9. Meteorology of AirPollution :-R.S. Scores 1990 Ellis Hardood Pub.
10. Fundamentals of AirPollution:- 2" Ed. Arthur Co Stern Acad. Press 1984.
11. Air Pollution M.N. Rao, Mcgraw Hill 1993.
12. General Meterology :-Horace Robert Byers, Sc.D.Ed MCGRAW Hill Book Companynew YorkToronta, London.
13. EnviromentalChemistryA.K.De. Wiley Interscience.
14. Environmental ChemicalAnalysis :- 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. EnvironmentalGeology : 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
20. Physical Climatology-William D.Sellers.
21. Clirnatology-Bernhard-Haurwitz and J.M. Austin.
22. Dynamical and Physical Meteorology-George J.Haltiner and F.L. Martin
23. Physics of Monsoon-Keshav Murthy and Sankar Rao.
24. Essentials of meteorology-C.Donald Ahrens.
25. Foundation of Climatology-E.T.Stinger.
26. Climate Change : Emerging Scenarios and adaptation strategics :Vol 1 (2020) : Satish S. Patil, International Publication. Kanpur, (ISBN 978-93-87556-88-1)
27. Climate Change : Emerging Scenarios and adaptation strategies Vol:II (2020) : Satish S. Patil, International Publication. Kanpur, (ISBN 978-93-87556-88-1)
28. An Introduction to Climate-G.W.Threwartha.
29. The Nature and Causes of Climate Change-Goodies,Paultskaf and Davies.

Semester - I

LC: ENV 441: Lab Course-I

(Based on FC ENV-401)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Determination of GPP& NPP water body used for aquaculture purpose by light and dark bottle technique.
2. Identification and qualitative study of phytoplankton in water body used for fish cultivation by man.
3. Identification and qualitative study of zooplanktons in water body used for fish cultivation by man
4. Ecological study of living organisms from human habitat / man modified ecosystem, which ensures food security of man.
5. Quantitative analysis of planktons by Sedgwick rafter cell method.
6. Estimation of biomass from agricultural cropland / grazing grassland by harvest method.
7. Productivity study of agricultural cropland / grazing grassland by harvest method.
8. Determination of relative density of species from man modified ecosystem or from forest ecosystem by using simulation.
9. Determination of relative frequency of species from man modified ecosystem or from forest ecosystem by using simulation.
10. Determination of relative abundance of species from man modified ecosystem or from forest ecosystem by using simulation.
11. Identification pest species from man modifies ecosystem / agricultural crop.
12. Profile study of natural pond/lake and manmade reservoir.
13. To study the cover and based area study of tree species
14. To study the light intensity by sunshine record.

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.
4. Visit to man modified ecosystem for collection of specimens / ecological study**.**

Semester - I

LC: ENV 442: Lab Course-II

(Based on FC ENV- 402)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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 .

Semester - I

LC: ENV 443:Lab Course – III

(Based on CC ENV- 403)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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 bio-monitoring .

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

Semester - I

ELC(ENV 444 – A :Lab Course – IV)

(Based on EC ENV- 421 -A)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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.

Semester - I

ELC (ENV 444-B :Lab Course – IV)

(Based on EC ENV-421-B)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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 of NO_x in ambient air by high volume sampler (HVS).
10. Measurement of SO_X by high volume sampler (HVS).
11. Measurement of SPM by using high volume sampler (HVS).
12. Measurement of RSPM by using Respirable Dust Sampler.
13. Identification of minerals on the basis of physical properties (10 minerals specimens).
14. Identification of rocks: Igneous rock, sedimentary rock and metamorphic rocks.

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			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	10 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	40 Marks
Total Credit	:-	02	**Total Marks**	**:-**	**50 Marks**

Unit-I: **10+2**

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

Unit- **II:** **13+2**

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

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 important output from 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 &BartjanPennink, Springer.

Semester – II

CC (Env-404 :- Environmental Biotechnology)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Students will able to understand biotechnology.
2. Students will able to assess biotechnological tools used in pollution abatements.
3. Students will able understand bio-safety regulations and protocol**.**

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

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

Definition, scope and concept of Biotechnological Interdisciplinary, Activity of Biotechnology, Development of Biotechnology in all sectors.

Unit-II Bioremediation: 10+2

Concept, principles and application; types-Insitu, Exsitu; Microbes involved; rhino-remediation, phyto-remediation, bio-mining ; microbial leaching of low grade mineral ores; molecular probes for organisms in mines and mine tailings .

UnitIII :- Biotechnology for Pollution Abatement: 10+2

Air pollution abatement; bio-filters, bios-crabbers, Bio-trickling filters; water pollution abatement; Activated sludge process, Sequence batch reactors, rotation biological contractors (RBC), fluidized bed reactor, anaerobic sequencing batch reactor (ASBR), anaerobic packed bed reactor (APBR), two phase anaerobic digester.

Unit —IV :- Environmental Biotechnology: 10+2

Fermentations technology, Vermiculture technology, microbial composting technology, Bio-fertilizer technology, waste management technology-role of microorganisms in the degradation of natural and man-made compounds-pesticides recalcitrant chemicals, persistent organic pollutants (POP).

Unit –V :-GMOs and Bio-safety: 10+2

Genetically modified organisms and their environmental implications- pros and cons (Eg.BT cotton, GM food) GEAC and their roles, Cartagena protocol, bio-safety regulations, scope of bio-safety, regulatory frame work, bio-safety assessment and decision making, development in tralisgertic research and its application in India.

Current development in the subject.

Course Outcome :

On completion of this course, students should able to :

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

References :-

1. Microbiology-P.D. Sharma ,Rustogi publisher, meerut
2. Fundamental principle of bacteriology-P.C.Salle
3. Microbiology-Pelczar, M.S. Chand.

4. Global environmental Biotechnology : D.L. Wise.
5. Methods in Biotechnology: Hans Peter Schmauder
6. Introduction to Environmental Biotechnology, A.K.Chatterji, Prentice Hall of India Pvt.Ltd, New Delhi.
7. Environmental Biotechnology-Basis Concepts and Applications Indu Shekhar Thakur I.K. International Pvt.Ltd.New Delhi.
8. Environmental Biotechnology S.K. Agawal.APH Publishing Corp, New Delhi.
9. Elements of Biotechnology, by Jogdand S.N., Himalaya Publishing House, New Delhi.
10. Biotechnology,byB.D.Singh, Kalyani Publishers,New Delhi.
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Semester – II

CC (Env-405 :- Application of 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 nanotubes, green nano particle, and biocompatibility for resource conservation, ecosystems, non-medical applications and human being.
4. The use of green chemistry in industries, fuel cell, solar energy, electric vehicles, solar photovoltaic technology and in biofuel production etc.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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 for minimization of wastes and environmentallybalanced industrial complexes.
2. Design green product to maintain quality predictability, functionality and upgradability to improve performance of the products in environment
3. Apply the concept of green nanotechnology, carbon nano tubes, green nano particles and biocompatibility for resource conservation, ecosystems, non medical applications and human being.
4. Choose the applications of green chemistry in industries, fuel cell, solar photovoltaic technology and in bio fuel product etc.

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Semester – II

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

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

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

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit-I :- Water and Wastewater Treatment Technologies : **10+2**

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

Unit-II: - Industrial Wastewater Treatment **10+2**

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

Unit III: Advanced Waste water Treatment Techniques : **10+2**

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

Unit —IV :- Industrial Hazardous Waste Treatment and Disposal Methods **10+2**

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

Unit —IV: - Industrial Air Pollution and control Techniques: **10+2**

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

Unit -V: - Environmental Engineering and Biotechnology **10+2**

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

Course Outcome

Students should able to:

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

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Semester – II

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

(Theory Elective Course with 04 credits)

Course Objectives

Students will be able to know

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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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.

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

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Semester – II

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

(Theory Elective Course with 04 credits)

Course Objectives

Students will be able to know

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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

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

a) 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.

b) Use of the statistical components for the representation of data obtained from environmental system: Measures of central tendency-mean and its types, Median, mode, Measures of dispersion-Variance, Standard Deviation, Mean Deviation, Coefficient of Variation, Range and quartile deviation, Concept and types of Skewness and Kurtosis in collected environmental data.

Unit-IL-Application of Probability in environmental data : **10+2**

Basic Conceptof probability - Addition and multiplication theorem of probability, Conditional probability and unconditional probability, Problems on probability depending on environmental systems data or data of environmental case studies.

Unit- 111:-Applications of test of significance in environmental data : **10+2**

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

Unit- IV:-Computer applications in environmental science **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 intemet in environmental science, Applications of computer in environmental science.

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

Introduction to environment systems, concept of modeling and simulations, Types of modeling, simple regression models, Validation of models and forecasting, Population growth model,Lotka Volterra model, Gaussian plume model for dispersion of air pollutants, Box and pipe model for energy flow in ecosystem, Point source stream pollution model.

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

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Semester – II

LC: ENV 445:Lab Course – V

(Based on CC ENV- 404)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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 broth.
10. To study the growth pattern of salmonella on xylose-lysin-agar medium..
11. Developing vermiculture technology.
12. Encapsulation techniques.
13. Demonstration of PCR techniques.

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.

Semester – II

LC: ENV 446:Lab Course – VI

(Based on CC ENV- 405)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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 ecolabelling from pharmaceuticals, foods, cosmetics, automobiles and electronic industry.
6. To assess the impact of materials on biodiversity, resources and ecosystems.
7. To study bio-fuel production methods and characterization for biodiesel and bio-ethanol.
8. To study the application of green chemistry concept in industries.
9. To study application of green chemistry concept in agricultural related practices and food processingunits.
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 andcharacterization.
12. Determine the green building rating systems used around world.
13. Categorization of the different levels of green building certification.
14. Study of different types of green building materials used in India.
15. Study of green jobs and opportunities of green economy.

Semester – II

LC: ENV 447:Lab Course – VII

(Based on CC ENV- 406)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

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

Semester – II

ELC: ENV 448- A :Lab Course – VIII

(Based on EC ENV- 422 -A)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 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.

Semester – II

ELC: ENV 448- B :Lab Course – VIII

(Based on EC ENV- 422 -B)

Lab Course	:-	4 hr/week	**Evaluation Scheme**

Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Calculation of central tendency parameters:
   i) Mean value calculation from the primary data collected from environmental system.
   ii) Mode value calculation from the primary data collected from environmental system
   iii) Median value calculation from the primary data collected from environmental system
2. Calculation of standard deviation to the primary data collected from environmental system.
3. Calculation of Karl Person's Co-efficient of Co-relation to the data obtained from environmental study.
4. Calculation of Regression equation Y on X & X on Y from the environmental variables data and calculation of unknown value of dependent variable by using regression equation.
5. Calculation of variance from the environmental data.
6. Calculation of standard error (SE) from environmental data.
7. Problems on probability based on environmental data.
8. Application oft-test for conclusion from environmental data.
9. Application of Z test for conclusion from environmental data.
10. Application of F test for conclusion from environmental data.
11. Application of ANOVA test for conclusion from environmental data.
12. Application of chi square test for conclusion from environmental data.
13. Application of Power point presentation in environmental data presentation.
14. Use of MS-Excel in environmental data analysis.
15. Application of MS Word in environmental data presentation

Semester – III

CC (Env-501 :- Solid 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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I- General Introduction:

Introduction to MSW, Sources and types of solid waste, On-site and Off-site disposal options, Protective measures, Problems associated with system, Design of appropriate waste management system.

Unit II- Treatment Methods for sewage sludge:

Introduction, Identification factors in selecting the best system, Sludge treatment and disposal processes, Chemical stabilization, Incineration, Heath Furnace system, Composting, Sludge disposal regulation.

Unit III- Integrated Solid Waste Management:

Approaches to integrated waste management, Assessment of Solid Waste Management (SWM), Policies, Laws and Acts, Financing mechanism, Stakeholder'sparticipation, and Case studies towards sustainable waste management.

Unit- IV- Managing Risk and Hazards:

Development of risk and hazardous management systems, Hazards and risk analysis methods, Hazardous waste incineration – trends and prospects, Hazard management in chemical industry, Policy issues and problems in hazardous management.

Unit-V- Life Cycle Analysis:

Life cycle analysis of material recycling, Paper recycling, Glas recycling, Plastic recycling, E-Waste management, , Environmental Management Plan.(EMP).

Unite- VI- Landfilling Methods and Operations:

Introduction, Landfilling methods and operations, Landfill designs, Leachates release and migration, Types of bioreactors, Landfill leachates treatment by electrochemical oxidation, Combined landfill gas and leachate extraction system.

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

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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: - 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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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.

Semester – III

CC (Env-503 : - 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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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,freeencyclopedia.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.
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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.
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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).
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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

EC (Env-521A :- Mooc's Courses)

(Theory Core Course with 04 credits)

(Online Mode)

Course Objectives

Students will be able to know

1. Students will be able to know the present status of plastic waste as a pollutant and how to mitigate its problem.
2. The students will be able to understand that, how the modeling can be used to study the environmental problems.

3. The students will gain the knowledge about energy, economics and policies.

The students has to earn 04 credits from the following list of Mooc's Courses on SWAYAM platform by **Online mode** and should secure certificate from the concern organization. The evaluation processes will be followed as per university rules.

List:

1. Business Environment - I I S Jaipur (04 Credits)
2. Communication Skills Modes and Knowledge Dissemination - N I TT I & R, Chandighad(03 Credits)
3. Business and Sustainable Development, - I I T Bombay, Mumbai (01 Credit)
4. Environmental Studies, - Devi Ahilaya University, Indore (04 Credits)
5. Plastic Waste Management , I I T Kharagpur (02 Credits)
6. Energy Economics and policies, - I I T Mandi (02 Credits)

Semester – III

EC (Env-521 B :- Environmental Toxicology and Biodiversity Assessment)

(Theory Core Course with 04 credits)

(Offline Mode)

Course Objectives

Students will be able to know

4. Scope of Toxicology, Source's of Toxicants in Atmospheres, Hydrosphere & Soil.
5. Recent Trend's in pesticides, factors affecting metabolism of Xenobiotics.

6. Bio-assay Test, Protocol of Toxicity Evaluation.
7. Important of Biodiversity, Causes of Loss of Biodiversity.
8. Need of Biodiversity Assessment, Biodiversity Measurements & Extinct Species.

Teaching Scheme			**Evaluation Scheme**		
Lectures	:-	4 hr/week			
Tutorials	:-	1 hr/ week	Internal Assessment	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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 patriciaE.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, LeaeFabiger.
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

LC: ENV 541: Lab Course – IX

(Based on CC Env. 501)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Determination pH & electrical conductance of municipal solid waste.
2. Determination of totalwater 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 the conventional signs and symbols used in hazardous waste study.
12. Geological investigation and identification of landfill sites for solid waste management.
13. To study the leachable calcium and magnesium content from vermin-compost prepared from municipal solid waste.
14. Developing appropriate microbial consortium for land applied effluents. (Bioremediation)

Semester – III

LC: ENV 542: Lab Course – X

(Based on CC Env. 502)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. To study the total carbon content present in plant biomass.
2. To study the calorific value of plant biomass by titrometric method/ bomb calorimetric method.
3. Study of carbon footprint of product.
4. Determination of rate of carbon fixation in aquatic ecosystem by phytoplankton.
5. Immobilization of cultured bacterial sample.
6. Measurement of carbon content from various soil samples by ignition method.
7. Determination of various parameters from prepared compost and comparison with standards.
8. Determination of air pollution index.
9. Determination of soil pollution index.
10. Determination of urban infrastructure index.
11. Determination of water quality index.
12. Determination of Environmental pollution index (EPI).
13. Determination of life quality index.
14. Determination of Comprehensive environmental pollution index (CEPI).

Semester – III

LC: ENV 543: Lab Course – XI

(Based on CC Env. 503)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. To determine moisture from stack emission gases.
2. To determine the density of stack emission gases.
3. Designing a manual for stack monitoring system.
4. To study trouble shooting mechanism may be encountered in the use of stack sampler.
5. Evaluation of atmospheric pollutants in working environment of industry as a field study.
6. To prepare a flow chart treatability study of industrial effluents.
7. To demonstrate treatability of various industrial effluents.
8. Application of nano particles for pollution abatement.
9. Synthesis of nano particles using plant resources.
10. Application of enzyme in process development.
11. Process modification in Clean Development Mechanism.
12. Removal of heavy metal from waste water by using aquatic plants.
13. Removal of COD from waste water by using root zone technology.
14. Determination of carbon monoxide and hydrocarbons from automobile exhaust.
15. Biological adsorption atmospheric dust particles or other pollutants.

Semester – III

LC: ENV 544 : Lab Course – XII

(Based on environmental components)

Lab Course	:-	4 hr/week			**Evaluation Scheme**
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Determination of water soluble aluminum compounds as Alumina (Al2O3) from alum by using gravimetric method.
2. Determination of water soluble aluminum compounds as Alumina (Al2O3) from alum by using volumetric method.
3. Determination of different adsorbing capacity of different activated carbon prepared from different plant materials.
4. Determination of stability of bleaching powder.
5. Determination of silicates from caustic soda.
6. Determination of chlorides from caustic soda.
7. Determination of sulphates from caustic soda.
8. Determination of bulk density of filter sand.
9. Determination of percentage of oxides and hydroxides in lime.
10. Determination of active functional groups of activated carbon by using FTIR spectroscopy.
11. Determination of iodine number of activated carbon.
12. Determination of ozone by using spectrophotometric method.
13. Analysis of chloroflourocarbons and chlorinated hydrocarbons by Gas chromatography.
14. Determination of metal pollutants (As, Cr, Fe, Pb, Mn, etc.) from provided sample.
15. Determination of pesticide residue in given sample by TLC / GLC method.

Semester – III

SC (Env-522:- Global Environmental Crises& Climate Change)

(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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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 BachoaoAndolan, 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 ChittabrataPalit 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 RituAneja
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:- RS & GIS Application in Environment)

(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			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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 FraneisLtd.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 – 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	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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 :EIA
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 – IV

CC (Env-506:- Sustainable Urban & Rural Developmental Planning)

(Theory Core Course with 04 credits)

Course Objectives

Students will be able to know

1. Concept of sustainable development.
2. Concept of sustainable urban development and its applications.
3. Concept of rural development and its importance.

4. The understanding of urban and rural problems and mitigation by planning it for sustainable development.

Teaching Scheme			Evaluation Scheme		
Lectures	:-	4hr/week			
Tutorials	:-	1 hr/ week	Continuous Internal Assessment by Teacher	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 Marks
Total Credit	:-	04	**Total Marks**	**:-**	**100 Marks**

Unit I:Sustainable Ruraldevelopment: Concept and theory, Planning the rural –urban interface under sustainable principle, Sustainable rural development in India: Issues and challenges, Sustainable rural development initiatives taken by Government of India, Rural developmental strategies, Sustainable rural technologies: Food processing, watershed management, , organic farming, rural tourism, ICT in rural technology, IOT in agriculture.
Rural development- Planning for rural development.- components of planning, village level planning, block and districtlevel planning,

Unit II: Urban development:
Urbanization- causes and impacts, strategic approach to urban development, sustainable urban development and planning, Good governance , the strategic approach in support of development, Urban themes and sectoral issues, strategies for regional urban planning,
Urban Transportation and planning : Urban Transportation problems & Externalities- Congestion, Safety, Emissions, etc.; Transport planning; Implementation hierarchical levels of Urban Transport Planning: Master plans, detailed development plans; Planning and design of sustainable urban mobility.

Unite III: Urban Services: Different type of municipal services, Role of stakeholders in Urban services and finance, Public private partnerships, Integrated municipal solid waste management and plan preparation for urban areas; Decentralized waste management, Municipal solid waste management- Operation and maintenance; Solid Waste generationand minimization; Waste forecasting; Waste collection in urban areas- Equipment, vehicles; Waste disposal from urban areas- Landfill siting criteria, Landfill area calculation, Landfill Types, Landfill Design, Landfill phasing.

Unite IV: Municipal health services: Public health challenges, Health facilities, Stakeholders, Improving healthcare access for the urban poor, Community based healthcare programs, Epidemic and pandemic control, Governments health programs
Other urban services and activities: Street sweeping, Cleaning of surface drains; Street lighting services, Fire services, Urban forestry, environment and ecology, Provision of parks, gardens and playground, burial grounds and cremation facilities;
open space management, urban forest / vegetation management, utility management in urban areas; Sustainable urban Development- principle of sustainable urban development, urban growth management town planning.

Unit V:Advanced waste management technologies: Waste to energy, Bio-methanation, Refuse derived fuel, Evaluation of alternative technologies, Plastic waste and Hazardous waste management; wealth from waste etc.

References / Books

1. Hutchinson, B.G., Principles of Urban Transport Systems Planning, McGraw Hill, London, 1974.
2. Khisty, C. Jotin and Lall, B. Kent., Transportation Engineering and Planning, 3rd Edition, Pearson India, 2001
3. Papacostas, C. S., and Prevedouros, P. D., Transportation Engineering and Planning. 3rd Edition, Prentice - Hall of India Pvt. Ltd., 2002.
4. Garber N.J., and Hoel L.A., Traffic and Highway Engineering, 4th Edition, Cengage Learning, 2009
5. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2013
6. Municipal solid waste management manual Part I & II. CPHEEO, India
7 What a Waste: Solid Waste Management in Asia, The International Bank for Reconstruction and Development/The World Bank

8.Agriculture and Rural Development 2011: Rural Development in European Union A stastical and Information Report 2011
9. Sustainable Rural Development : A regional Perspective, 2009; A Annual Report on Monitoring
10. Introduction to Sustainable Rural Development: Key Concepts and Theoretical Foundation 2012. Russain State Agrarian University, Russia.

Semester – IV

EC (Env-523A: - Mooc's Course on SWAYAM platform)

(Theory Core Course with 04 credits)

(Online Mode)

Course Objectives

1. To learn about the basic /advanced components of environmental science.
2. Acquire the skill in the field of environmental science.
3. Acquisition of knowledge by online mode.

The students has to earn 04 credits from the following list of Mooc's Courses on SWAYAM platform by **Online mode** and should secure certificate from the concern organization.
The evaluation processes will be followed as per university rules.

List of Courses:

1. Ecology and Environmental Ethics: Problems and Perspectives; Amrita Viswa Vidyapeeth (04 Credits)
2. Environmental Communication; University of Calicut. (04 credits)
3. Environmental Law; National Law University, New Delhi (04 credits)
4. Resources and Environment; Maharaja College, University of Mysore, Mysore (04 Credits)
5. Water Resources and Water**shed** Management;Osmania University, Hyderabad. (04 credits)

Semester – IV

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

(Theory Core Course with 04 credits)

(Offline Mode)

Course Objectives

Students will be able to know

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

Teaching Scheme **Evaluation Scheme**

Lectures :- 4 hr/week

Tutorials	:-	1 hr/ week	Internal Assessment	:-	20 Marks
Test	:-	1 hr/week	Sem-End Examination	:-	80 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

Semester – IV

LC: ENV 545: Lab Course – XIII
(Based on theory papers)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Marginal information of toposheet and indexing of toposheet.
2. To study the conventional signs and symbols from toposheet
3. Interpretation of toposheet for specific objects.

4. To study the principle and application of: a)Pocket Stereoscopes, b) Mirror stereoscope, c) Parallax Bar.
5. Stereoscopic vision test by using pocket stereoscope.
6. Determination of scale of aerial photograph and satellite image.
7. Identification of features on vertical aerial photograph.
8. Orientation of sterio- model under mirror stereoscope and detection of objects from steriopairs
9. Land use and land cover study / mapping of objects from aerial photograph..
10. Determination of coordinates of selected points / area by using GPS for confirmation of objects from satellite image /toposheet(ground trouthing).
11. Browsing oftoposheet /satellite image in GIS software and georeferencing.
12. Digital image processing- stacking of image, image rectification / image enhancement , image display in RGB .
13. Image interpretation- unsupervised and supervised classification.
14. To study the land use and land cover visually by using satellite images and google image.
15. Preparation of shape file of an area and display information in point line and polygon form.

Semester – IV

LC: ENV 546: Lab Course – XIV
(Based on theory papers)

Lab Course	:-	4 hr/week	**Evaluation Scheme**		
Assignment / field work/ outreach activities	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**10 Marks**
			Sem-End Examination	:-	**40 Marks**
Total Credit	:-	**02**	**Total Marks**	:-	**50 Marks**

1. Environmental audit protocoland audit process of any two industries.
2. Standard operational procedure (SOP) for Environmental Impact Assessment.

3. Preparation of TOR (Turn of Reference) for EIA in any two industries
4. Study of environmental parameters during pre-audit, onsite audit and post audit activities inEIA.
5. Preparation of checklist for the environmental impact assessment for construction project or any other developmental activity.
6. To study the environmental impact of any one developmental activity by using network method.
7. Estimation of water requirement for industry using thumb rule
8. Estimation of sewage treatment plant capacity by thumb rule
9. To study the water quality of river or water bodies to discharge its water in river by thumb rule.
10. To study the required contents in EIA report along with public hearing with respect to EIA notification 2006.
11. Estimation of stack height on the basis of particulate matter using thumb rule.
12. To calculate raw water requirement for a power plant by thumb rule.
13. To study the life cycle assessment technique for the assessment of environmental impacts associated with all the stages of products life from cradle to grave.
14. Preparation of EMP statement for any one development activities.
15. Preparation of SIA report for tourism project / activities.

Semester – IV

LC: ENV 547: Project + Internship + Field visit / Tour + Review writing + Research Proposal writing

Lab Course	:-	8hr/week	**Evaluation Scheme**		
Project work / field work/ project writing etc.	:-	2 hr/week	Continuous Internal Assessment byTeacher	:-	**20 Marks**
			Sem-End Examination	:-	**80 Marks**
Total Credit	:-	**04**	**Total Marks**	:-	**100 Marks**

1. Project work / dissertation 40 marks
2. Internship / in plant training report 20 Marks
3. Visit / Tour report 10 Marks
4. Review writing 10 Marks
5. Research Project Proposal writing 20 Marks

Note:

I. **The project internship is to be performed during summer vacation after completion of First year.**
II. **Allotment of project work should be before the commencement of third semester.**
III. **The field visits / tours to be arranged during third semester tenure only.**