Annexure: I

Faculty of Science

Department of Environmental Science

Ordinance, Curriculum & Syllabus

Master of Science (Environmental Science)

(2020-21)

Shree Guru Gobind Singh Tricentenary University, Gurugram (Haryana)- 122505, India

SHREE GURU GOBIND SINGH TRICENTENARY (SGT) UNIVERSITY, BUDHERA, GURUGRAM (HARYANA)

FACULTY OF SCIENCE

MASTER OF SCIENCE [ENVIRONMENTAL SCIENCE]

ORDINANCE

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of the country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning (online & offline) process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.

Department of Environmental Science, Faculty of Science, Shree Guru Gobind Singh Tricentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guidelines in its Postgraduate (PG) program (M. Sc. Environmental Science).

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions within India and across countries the community grade point average (CGPA) has been introduced in this PG program. The guidelines are as follows:

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed pool of courses comprising core, elective, skill and ability enhancement courses. The courses can be evaluated by a uniform grading system in the higher education system. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in the evaluation system

and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

   ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

d. **Ability Enhancement Compulsory Course:** The course based upon the content that leads to the development of a professional of ability.

e. **Open Elective Course:** The course based upon the content that enhances interdisciplinary knowledge

2. Program Educational Objectives (PEOs):

i. To create and disseminate fundamental knowledge of environmental science.

ii. To sensitize students towards environmental concerns, issues and related mitigation strategies.

iii. To provide practical training on analytical instruments and techniques to monitor, assess and analyze environmental problems.

iv. To educate students to apply their knowledge for efficient decision-making, finding solutions to problems, resource management and ensuring sustainable development related to environmental aspects.

v. To prepare students for successful career in the field of environmental research, industries, consultancy and NGOs etc.

3. Program Outcomes (POs):

At completion of the program the student will be able to:

PO 1. Disciplinary knowledge:

Understand environmental contemporary problems, legislations and standards at social and corporate level.

PO 2. Critical thinking and scientific reasoning:

Critically investigate and evaluate complex issues, concepts and theories related to environmental concerns and conceptualize the reasons behind them.

PO 3. Problem Solving:

Apply principles of environmental science, to provide scientifically sound and socially acceptable solutions for day-to-day environmental problems.

PO 4. Research related skills:

Plan, conduct and manage basic research projects, based on environmental issues while using their scientific skills in sample collection, analysis and data interpretation.

PO 5. Social interaction and effective citizenship:

Bridge the gap between science and society in achieving ecosystem restoration, conservation and management including well-being of the society and nation.

PO 6. Effective communication:

Able to communicate scientific findings and final outcomes in oral and written form to specialist and non-specialist audiences.

PO 7. Multicultural competency and leadership readiness:

Work effectively either independently or in a group or as team leader in different multicultural habitats for wellbeing of the nature

PO 8. Environmental sustainability:

Apply his / her the knowledge to conserve natural resources and minimize environmental degradation to achieve environmental sustainability.

PO 9. Ethics:

Participate and contribute ethically in different roles at society level as an environmentally responsible citizen.

PO 10. Self-directed and lifelong learning:

Learn and engage themselves in various community services designed to aware the society about current environmental problems and future preservation.

4. Definitions

i. **Course** means a unit of teaching / individual subject comprising of Lectures, Tutorials and / or Lab that typically lasts one academic term (semester / year) led by one or more instructors (teachers or professors), and has a fixed roster of students. Each Course shall have an individual Course Code e.g. Ecology (theory) and Ecology Lab-I (Lab) to be given separate course codes.

ii. **Credit** means a unit by which course work is measured. One hour of lecture / tutorial is equal to one credit and one hour of lab / workshop / project etc. is equal to half credit.

iii. **Program** means any combination of courses and/or requirements leading to a degree, diploma or certificate e.g. M.Sc. (Environmental Science).

iv. **Program Structure** means listing of various courses of a program and the credits associated with them as L-T-P structure which indicates the number of lecture hours/week, number of tutorial hours/week and number of practical hours/week to be devoted for each course e.g. Organic Spectroscopy (3-0-2). This means that this course shall have 3 hours of lecture per week and 4 hours of practical work per week.

v. **Scheme of Study** means the Academic Term wise listing of all the courses along with distribution of their formative and summative assessment criteria, which will be normally offered during the entire Program.

vi. **Semester Grade Point Average (SGPA)** means the ratio of sum of the product of the number of credits with the numerical grade scored by a student in all the courses taken by a student in a particular Semester and the sum of the number of credits of all the Courses undergone by a student, i.e. SGPA(Si) =$\sum$ (Ci x Gi) /$\sum$Ci.

vii. **Cumulative Grade Point Average (CGPA)** means the ratio of sum of the product of the number of credits with the numerical grade scored by a student in all the courses taken by a student in all Semesters and the sum of the number of credits of all the Courses undergone by a student i.e, CGPA =$\sum$(Ci x Si) / $\sum$Ci.

viii. **Open Elective Course** means a course offered by a Department / Faculty other than the parent Department / Faculty.

5. Duration and Nomenclature of the Program:

The duration of M.Sc. Environmental Science program shall be of two academic years consisting of four (04) semesters (16 weeks per semester) under Choice Based Credit System (CBCS). On successful completion of all the four semesters, the student will be awarded M.Sc. Environmental Science degree. The student shall complete the program within a maximum period of 4 years from the date of admission to the first semester as per N+2 rule by UGC (where N stands for minimum duration years of the program). However, in exceptional circumstances a further extension of one more year may be granted. In such cases, permission from competent authorities of the University is mandatory, failing which he/she will be disqualified from the program.

6. Eligibility criteria for Admission in a Program

For admission to the 1st Semester of M.Sc. (Environmental Science) course, the candidate must have passed B.Sc. (Non-Medical/ Environmental Sciences/Life Sciences/Bio Sciences/Agriculture etc.) /B.Tech, with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

7. Registration of Courses at the start of an academic term

Every student admitted in a Program shall be required to register various courses which he/she needs to undergo in a particular Semester as per the approved Scheme of Study applicable to M.Sc. Environmental Science Program in the prescribed format within the defined timelines.

8. Medium of Instructions:

The medium of the instructions for all Programs shall be English only.

9. Scheme of Study and Syllabi

(i) Scheme of Study and Syllabi shall be governed by the UGC regulations.

(ii) In M.Sc. Environmental Science, formal classes / labs shall be held for 5 days in a week i.e. Monday to Friday and Saturday shall be reserved for Professional Activities (Curricular / Co-curricular and Extra-Curricular).

(iii) Minimum number of Credits required to earn M.Sc. Environmental Science degree shall be 82 credits.

(iv) Provision has been made in the Scheme of Study for students to earn up to three credits in each Semester through online MOOC courses on the specified portals.

For example, a student may enroll in the courses offered on SWAYAM platform of the Government of India (https://swayam.gov.in/). The courses offered on SWAYAM on SWAYAM portal are offered by the top ranked Universities / Institutions of National Importance spanning 4-12 weeks in higher education domain. A 4-week, 8 week and 12 or more week courses may have 1, 2 & 3 credits respectively. The credits will be accepted if the student appears in the term end examination conducted by the host institution and earns credits for the same with appropriate grade. Similarly, other such platforms may be identified by the department time to time.

(v) For Open Elective Course, a slot of one hour (preferably last lecture) during first three days of the week (Monday to Wednesday) for the whole semester will be earmarked in the time table.

(vi) The syllabus of various theory courses has been designed and distributed in four units and is balanced in terms of Academic workload (e.g. the syllabus has been designed in such a way that the entire theory syllabus is to be covered in 11C hours where C means number of credits per week. 2C/3C hours shall be utilized for discussing performance of the students in class test/assignment and covering currently relevant topics related to the subject).

(vii) The weightage of continuous/ formative evaluation and term-end/ summative evaluation for theory classes is in the ratio of 40 and 60 respectively. Every course has 100 marks for evaluation.

(viii) Continuous/ Formative Evaluation of theory courses is done in following manner:

a) Mid Semester Examination (Subjective/Objective, Average of two) : 20 Marks

b) Assignments (Average of two) : 10 Marks

c) Professional Activities (Problems/Projects/Seminars/Case Study etc.) : 10 Marks

(ix) A student will be required to register for Professional Activities in the very beginning of the Academic Term (semester) which will be open ended and consists of curricular / co-curricular / extra-curricular activities. Such activities will include extra projects beyond syllabus (SGTU Synergy / Competitive Projects such as Hackathon / Robocon /BAJA/ SAE etc.), extension and activities related to clubs / societies / chapters of professional bodies / NSS / NCC / Sports etc. Each such activity shall be undertaken by the student under the supervision of a Faculty Member who will keep records of the activity undertaken by the student. Faculty Mentor concerned shall be informed about all the activities being undertaken by every student. Each student shall maintain a diary / log book of activities perform by her/him which will be countersigned by the Faculty Activity in-charge on fortnightly basis. Three weeks before the last day of classes, every student shall submit a portfolio of activities performed by him/her along with diaries / log books to the Faculty Mentor concerned. Head of the Department concerned shall constitute a Portfolio Evaluation Committee consisting of two Faculty members of the Department and a representative of Dean Student Welfare. Portfolio Evaluation Committee shall evaluate the performance of each student separately and award marks on scale of 0 to 10 based upon the efforts put by each student and the outcomes. Portfolio Evaluation Committee shall submit the evaluation report to the Head of the Department concerned who after satisfying herself/himself about the quality of evaluation shall notify the marks to all the Teachers taking theory classes in that Semester for incorporating marks earmarked for professional activities. Such professional activities shall be undertaken on week days after working hours and Saturdays. This provision / evaluation shall measure the group activities, attitude and behavior of the student.

(x) The weightage of continuous/formative evaluation and term-end/summative evaluation of lab classes/summer training/project work are in the ratio of 60 and 40 respectively. Every lab course has 100 marks for evaluation.

(xi) Continuous/Formative Evaluation of lab courses is done in following manner: -

a)	Attendance and Regularity in Lab Work	:	10 Marks
b)	Lab/Project Work Report	:	10 Marks
c)	Mid Term Oral Exam./ Assessment	:	10 Marks
d)	Conduct/ Demonstration	:	30 Marks

The distribution of formative (internal) assessment marks for the summer training and project work to be kept in-line with the above.

10. Teacher Diary and Course File

(i) Every faculty member should maintain a separate Teacher Diary and a Course file for each course including lab courses.

(ii) Teacher Diary will be maintained in the pre-printed booklet issued from the university store which consists of Index, Syllabus (Theory and Lab), Subject Time Table, Course plan, Daily Diary (Course Coverage), Attendance Record, Evaluation (Internal Assessment) Record, List of Low Performing Students, Value Added Lecture Plan, Internal Practical (Continuous Evaluation) marks for laboratory, Parent Teacher Meeting Record etc.

(iii) Each course file shall contain the following:

- Syllabus
- Learning Resources prescribed
- Tutorial Sheets / Assignments
- Current and Previous Class Test / Sessional Question Papers
- Previous Term-End Examination Question Papers
- Lecture Notes (In the Current file only).

(iv) At the end of the semester, faculty member should submit Teacher Diary and Course File to HODs. HODs shall maintain the record of all course files for at least 5 years.

(v) Faculty member can withdraw his or her handwritten notes from the course file before submitting to HODs.

(vi) In case, Faculty member is allotted same subject in the next semester, then he/she can take same course file from Principal / HODs for few days for the reference purpose only.

11. Home Assignments

a) Home Assignment will be designed as per the final examination pattern as per the details given in the table.

		No of Questions per Assignment									
		1 Mark	2 Marks	4 Marks		6 Marks	10 Marks	12 Marks	Total Marks	Time Per Assignment (Minutes)	Total Time (Hrs.)
		Marks	1	2	4	6	10	12			
S.No.	Examination Pattern	No of Assignments	2.5	6	10	15	25	30			
1	Pattern	Two per course / One per two units	10	10	5	3	0	0	68	180	120

b) Minimum one home assignment shall be given from every two units.

Penalty for late submission of Home Assignment

a) Every Home Assignment shall have the Date of Release and last Date of Submission.

b) Penalty for late submission for Home Assignment in the form of %age of marks deduction shall be as under:

- Within 7 Calendar days: 20%
- Within 8 to 15 Calendar days: 40%
- More than 15 Calendar days: 50%

c) Teachers will ensure that there is no plagiarism in Home Assignment. If plagiarism is detected, a penalty of 30% may be levied and the student will be asked to re-submit the Home Assignment within 7 Calendar days.

12. Question Banking and Question Paper Setting for Term End Examination

(i) Question Banking for Term End Evaluation and home assignments shall be done with questions having 1, 2, 4 and 6 marks. The time allotted to each question shall be as under: -

Description	Marks			
	1	2	4	6
Term End Examination is for 60 marks	2.5 minutes	5 minutes	10 minutes	15 minutes

(ii) Each question shall be set in the following format: -

S. No.	Question	Marks Allotted	Time Allotted	Bloom Taxonomy (Cognitive Domain) Level	Difficulty Level	Course Outcome Number

(iii) Bloom Taxonomy (Cognitive Domain) levels shall be: Knowledge, Comprehension, Application, Analysis, Evaluation and Synthesis.

(iv) Difficulty levels shall be: Easy, Moderate and Difficult.

(v) Course Outcome Number shall be the number of specific outcomes given in the Course Objective and Course Outcome Matrix.

(vi) Term-End Examination question papers shall be set for all courses as per pattern given in the following table:

Question Paper Setting											
			No of Questions per subject								
			1 Mark	2 Marks	4 Marks	6 Marks	10 Marks	12 Marks	Case Study	Maximum Marks	Total Time (mins)
S.No.	Examination Pattern	Marks	1	2	4	6	10	12	40		
		No of Units↓/ Time→	2.5	5	10	15	25	30	NA		
1	Pattern	4	12	4	4	4	0	0	NA	60	150.0

Guidelines

a. Duration of end term theory examination: 3 hours.

b. Maximum marks: 60.

c. All Questions shall be compulsory.

d. The Question paper will be divided into four sections A, B, C and D.

e. Section A is compulsory and comprises of 12 questions of one mark each, 3 from each unit. The questions shall be asked in such a manner that there are no direct answers including one word answer, fill in the blanks or multiple choice questions (2.5 minutes each)

f. Section B comprises of 4 questions of 2 marks each, one from each unit. (5 minutes each)

g. Section C Comprises of 4 questions of 4 marks each, one from each unit. (10 minutes each). Each question may have two alternatives, out of which student will be required to attempt one.

h. Section D Comprises of 4 questions of 6 marks each, one from each unit. (15 minutes each). Each question may have two alternatives, out of which student will be required to attempt one.

i. The questions shall be set in such a manner that these cover first five level of Bloom Taxonomy i.e. Knowledge (10-15%), Comprehension (15-25%), Application (15-25%), Analysis (15-25%) and Synthesis (10-15% in normal papers; 50-80% in design papers).

j. The questions shall have three difficulty level namely Easy, Moderate and Difficult with ratio of 1:2:1 respectively.

k. Each question will be linked with the relevant CO.

13. Examination Scheme for Mid Semester Question Papers/ Class Test

(i) Mid Semester Question Papers/ Class Test shall be held normally in 7th and 13th weeks in the semester. Question papers shall be set from minimum 2 units (50% syllabus of each course). Duration shall be 90 minutes. Maximum marks shall be 30.

(ii) the structure of the sessional question papers shall remain the same as in term-end examination question paper.

14. Attendance Requirements/Eligibility to Appear in Term End Examination

(i) A student should have minimum 75% attendance in each Course to be eligible to appear in Term End Examination failing which she/he shall be detained from appearing in the Term End Examination of that particular Course. A maximum condonation to the extent of 10% may be granted by the Dean of Faculty of Science based upon genuine reasons such as hospitalization of self / parents / siblings, death in the family, participation in University sponsored activities outside the University campus and voluntary blood donation etc.

(ii) It will be the responsibility of the student to keep a track of her/his attendance in each Course in an Academic Term (semester) through ERP Portal and / or Course Teacher.

(iii) If a student is detained in a particular case, she/he shall be required to make-up the deficiency of attendance in the subsequent Academic Terms by attending classes, appearing in class tests and submitting additional home assignments. Once such student has made-up the deficiency, she/he will be allowed to appear in the next supplementary examination.

(iv) If the deficiency is more than 25% in a particular Course (having less than 50% attendance), the student will be required to pay additional fee specified by the university time to time for attending the classes again for which she/he will have to register for the Course(s) again in the subsequent term with the approval of the HOD/Dean concerned.

15. Term End Examination Rules

i. The Term End examination for all semesters shall ordinarily be held in the month of December and May/June for all regular and reappear candidates. The examination dates are fixed by the Controller of Examination with the approval of Vice Chancellor.

ii. Examination Rules including appointment of Examiners, Evaluation of answer sheets, compilation of results, calculation of SGPA/CGPA etc. shall be notified separately.

iii. Answer sheets for the Term End Examination shall be shown to the Examinees before compilation of result by the Faculty members as per schedule (normally in two parts) notified by Head of the Department concerned in consultation with the Controller of Examination.

iv. Normally the schedule for showing answer sheets to the examinees shall be so prepared that they are shown bulk of the answer sheets before last regular examination. Answer sheets related to last two/three exams can be shown within a week from the last date of examination.

v. If a student raises objection to the award of marks in a particular answer sheet, the same shall be considered by a Committee of two Faculty members appointed by Head of the Department and settled on the same day with the approval of Head of the Department concerned.

vi. No request for re-evaluation of answer sheets shall be entertained after the declaration of results.

16. Project / Dissertation

i. Topic Selection and Appointment of Guide/Supervisor: - Normally selection of project topic / research problem shall be finalized in the previous Semester. HOD concerned shall call applications for allotment of project topic / research problem from the students minimum six weeks before the last date of classes in the previous Semester along with a detailed proposal in the specified format.\

ii. HOD concerned shall constitute a Committee for allotment of project topic / research problem for dissertation consisting of minimum 3 Faculty members. The Committee will interview each student and submit the proposed project topic/research problem for each student along-with the suitable Project / Research Supervisor name. HOD shall approve the recommendation of the committee after satisfying herself/himself about the project topic, research problem and the recommended Supervisor. In case, a Project

requires a team activity in an undergraduate program, project team shall not have more-than 3 members and role of each team member shall be well defined.

iii. Student shall start working on the literature review in the previous Semester itself and start the project / research activities right from day-1 of the Academic Term in which the Project / Dissertation is included in the Scheme of Study.

iv. It will be mandatory for each student to publish/write at-least one review / research paper in SCOPUS / Web of Science indexed Journal to become eligible for the award of postgraduate degree. For the purpose of eligibility for the award of degree acceptance by the Journal will be sufficient.

v. Each student/team, as the case may be, shall submit minimum 3 copies of Project Report/ Dissertation in the specified format.

vi. Evaluation of Project/ Dissertation: A project/ dissertation undertaken by students shall be evaluated by a panel consisting of one external and one internal examiner. External examiner shall be appointed by the Dean of Faculty concerned out of the panel approved by the Vice Chancellor.

17. Internship / Field Training

The duration of the Internship will be 4 weeks of 4 credits. The formative and summative assessment marks are mentioned in the scheme of study. The final viva voce and reports will be adjudged by the joint Board of External and/or Internal Examiners.

18. Setting of Question Papers:

i. The Head of the Department/Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

ii. An examiner shall be allowed to set not more than two papers in a semester examination.

iii. The examiner(s) will set the question papers as per criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council of the University.

19. Evaluation Process – Theory and Practical:

i. **Evaluation of Answer Books**:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examiners with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

ii. **Fail/ Reappear candidates:**

Fail / Re-appear (Internal/External) candidate of any semester may appear in the re-appear exams, as an ex-student, during any term end exams of his/her remaining semesters and up to two years after his final semester as per N+2 rule.

iii. **Practical Examinations - Appointment of Examiner:**

The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners.

iv. **Marks Distribution:**

The distribution of marks in examination of the practical course will be as per the criteria given below:

a. Demonstration/Conduct/Presentation = 50% marks

b. Viva-Voce Examination = 50% marks

20. Evaluation and Gradation Criteria

Evaluation and Gradation Criteria for Continuous / Formative Assessment and Term End / Summative Assessment shall be followed as mention below:

(i) Minimum pass percentage will be 40% for Continuous/Formative Assessment and 40% for Term End/Summative Assessment respectively in all Theory/Practical Courses, making overall minimum pass percentage to be 40%.

(ii) If a student fails to obtain minimum 40% marks in Continuous/Formative Assessment in a Theory paper, he/she will be required to improve the same by appearing in additional class tests and submitting additional assignments before the close of the Academic term. Such students will be allowed to appear in the Term End Examination of that particular Course provided he/she meets the minimum attendance criteria.

However, If a student fails to meet the minimum requirement of 40% marks in Continuous/Formative Assessment before the Term End Exams, his/her result in that course will be shown as RL (FCA), in which case he/she will be required to obtain minimum 40% marks in Continuous/Formative Assessment by appearing in additional class tests and submitting additional assignments in subsequent terms.

(iii) The Letter and Numerical Grades for different range of percentage of marks obtained in Continuous and Term End Assessment together in a particular Course shall be as under:-

Percentage of Marks Obtained	Letter Grade	Numerical Grade	Performance Level
90% and above	O	10	Outstanding
80% and above but less than 90%	A+	9	Excellent
70% and above but less than 80%	A	8	Very Good
60% and above but less than 70%	B+	7	Good
50% and above but less than 60%	B	6	Above Average
Above 40% but less than 50%	C	5	Average
Minimum Pass Marks 40%	D	4	Pass
Below 40%	F	0	Fail

(iv) If it is required to calculate the percentage of marks obtained by a student for the entire Program, the same will be calculated by multiplying overall CGPA with a factor of 10.

(v) Grace marks of maximum 1% of the Theory courses may be permitted in a particular Semester.

21. Declaration of Results:

i. The Controller of Examinations shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.

ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

iii. The student whose result is declared late without any fault on his/her part may attend classes for the next higher semester provisionally at his /her own risk and responsibility, subject to his /her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her attendance/internal assessment in the next higher semester in which he / she was allowed to attend classes provisionally will stand cancelled.

22. Criteria for Promotion to Higher Semester(s):

All students shall be promoted to the next semester / year irrespective of the number of papers cleared/passed in the lower semesters.

23. Improvement of Division after the award of Degree

(i) A student may re-appear for improvement in not more than 5 theory papers only after award of degree within one year from the date of declaration of result of the last / final examination to improve his/her Division after depositing the prescribed Examination Fee as notified by the University from time to time.

(ii) In the case of re-appearance in paper, the result will be prepared on the basis of the candidate's best performance in either of the Examination.

24. Striking off the name of the defaulting students from the rolls of the University

(i) If a student remains absent for a continuous period of seven working days without written authorization from the Head of the Department of concerned, her/his name shall be struck off from the rolls of the University. However, such students may be re-admitted on payment of the Re-admission fee as prescribed by the University from time to time; if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

(ii) If a student fails to pay fees by the last cut of date as prescribed by the University from time to time, her/his name shall be struck off from the rolls of the University. However, such students may be re-admitted on payment of the Re-admission fee as prescribed by the University from time to time; if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

(iii) If a student is re-admitted, all his previous records shall be revived under the current structure, regulations and schedule of fees.

25. Other Provisions:

i. Nothing in the Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii. Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

iii. In case of any dispute, the Vice-Chancellor will be competent authority to interpret the rules and his interpretation shall be final.

M.Sc. (Environmental Science)

Syllabus (2020-21)

Programme Structure under Choice Based Credit System (CBCS)

SEMESTER	COURSE CODE	COURSE NAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
		Core Course (CC)								
I	17090101	Ecology	3	0	0	3	3	100	40	60
	17090102	Water Chemistry and Pollution	3	0	0	3	3	100	40	60
	17090103	Instrumentation and Analytics	3	0	0	3	3	100	40	60
	17090104	Ecology -Lab	0	0	4	4	2	100	60	40
	17090105	Water Chemistry and Pollution- Lab	0	0	4	4	2	100	60	40
	17090106	Instrumentation and Analytics Lab	0	0	4	4	2	100	60	40
		Skill Enhancement Course (SEC-1)								
	17090107	Environmental Legislations and policies	2	0	0	2	2	100	40	60
		Ability Enhancement Compulsory Course (AECC)								
	17090108	Professional Ethics & Human Values	2	0	0	2	2	100	40	60
			13	**0**	**12**	**25**	**19**	**800**	**380**	**420**
II		**Core Course (CC)**								
	17090201	Biodivesity and conservation	3	0	0	3	3	100	40	60
	17090202	Environmental Geology and Natural Resources	3	0	0	3	3	100	40	60
	17090203	Atmospheric Chemistry and Pollution	3	0	0	3	3	100	40	60
	17090204	Biodivesity and conservation- Lab	0	0	4	4	2	100	60	40
	17090205	Environmental Geology and Natural Resources-Lab	0	0	4	4	2	100	60	40
	17090206	Atmospheric Chemistry and Pollution Lab	0	0	4	4	2	100	60	40
		Skill Enhancement Courses (SEC-II)								
	17090207	Environmental Toxicology & Health	2	0	0	2	2	100	40	60
		Ability Enhancement Compulsory Courses (AECC)								
	17090208	Research Methodology and Statistics	2	0	0	2	2	100	40	60
Total Credits		**Core Courses**	**13**	**0**	**12**	**25**	**19**	**800**	**380**	**420**
	17090209	**Summer Training (4/6 weeks)**					**4**	**200**	**100**	**100**
III		**Core Courses**								
	17090301	Environmental Modeling & Simulations	3	0	0	3	3	100	40	60
	17090302	Soil Chemistry and Solid waste Management	3	0	0	3	3	100	40	60
	17090303	Fundamentals of Meteorology and Climatology	3	0	0	3	3	100	40	60
	17090304	Environmental Modeling & Simulations-Lab	0	0	4	4	2	100	60	40
	17090305	Soil Chemistry and Solid waste Management- Lab	0	0	4	4	2	100	60	40
	17090306	Fundamentals of Meteorology and Climatology Lab	0	0	4	4	2	100	60	40
		Skill Enhancement Course (SEC-3)								
	17090307	Environmental Impact Assessment and Risk Analysis	2	0	0	2	2	100	40	60
		Open Elective Course (From University Basket)								
	17090308	OEC	3	0	0	3	3	100	40	60
Total Credits			**14**	**0**	**12**	26	**20**	**800**	**380**	**420**
IV		**Research Training (Mandatory) (Common for all the specializations)**								
	17090401	Project Work	0	0	20	20	20	400	200	200
		Grand Total	**40**	**0**	**56**	**96**	**82**	**3000**	**1440**	**1560**

***Project Work**: The project work may be carried out at in-house labs or some outside agency having required facilities for the specified work. On successful completion of the project, every candidate has to submit a final dissertation/report to their concerned department.

Semester (Credits)	Core Courses	DSE Courses	SE Courses	AEC Courses	Research Training	Open Elective	Total
I	15	-	2	2	-	-	**19**
II	15	-	2	2	-	-	**19**
III	15	-	2	-	-	3	**20**
IV	-	-	-	-	20	-	**20**
Total	**45**	**-**	**6**	**4**	**20**	**3**	**78**
Summer Training (4/6 Weeks) after second semester							**04**
Online courses from MOOC (Sem – I to Sem – III) Maximum							**09**
Grand Total							**91**
Minimum Credits for award of degree							**82**

Category	Credits	%
Core Course(CC)	45	49%
Discipline Specific Elective Course(DSEC)	-	-
Skill Enhancement Course (SEC)	6	7%
Ability Enhancement Compulsory Course (AECC)	4	4%
Research Training	20	24%
Open Elective	3	3%
Summer Training after second semester	4	4%
Online courses from SWYAM (Sem – I to Sem – III)	9	10%
Total	91	

Name of the Faculty : Faculty of Science

Name of the Program : M. Sc. (Environmental Science) Session : 2020-21

Scheme of Study

Sr. No.	Semester/ Year	Course Code	Course Name	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE/OE/RT	L	T	P	Credits	Theory		Theory (Internal)					Practical				Practical (Internal)						Overall Maximum Marks		Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory+Internal+Practical+Oral/ Theory+Internal+Practical/ Theory+Practical
					ASSIGNED MARKS					Max	Pass	Midterm	Assignment	Professional Activities	Max	Pass	Demonstration/Presentation	Viva-voce	Max	Pass	Attendance	Project/Laboratory work	Midterm	Conduct/Demonstration	Max	Pass				
1		17090101	Ecology	Theory	Core	3	0	0	3	60	24	20	10	10	40	16	20	20	40	16	10	10	10	30	60	24	100			
2		17090102	Water Chemistry and Pollution	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
3		17090103	Instrumentation and Analytics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
4	I	17090104	Ecology -Lab	Practical	Core	0	0	4	2																		100	40	NO	Theory+Internal
5		17090105	Water Chemistry and Pollution- Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
6		17090106	Instrumentation and Analytics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
7		17090107	Environmental Legislations and policies	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16	20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
8		17090108	Professional Ethics & Human Values	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
																											100	40	NO	Theory+Internal
9		17090201	Biodiversity and Conservation	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
10		17090202	Environmental Geology and Natural Resources	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
11		17090203	Atmospheric Chemistry and Pollution	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
12		17090204	Biodiversity and Conservation- Lab	Practical	Core	0	0	4	2																		100	40	NO	Theory+Internal
13	II	17090205	Environmental Geology and Natural Resources- Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
14		17090206	Atmospheric Chemistry and Pollution -Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
15		17090207	Environmental Toxicology & Health	Theory	SEC	2	0	0	2	60	20	20	10	10	40	20	20	20	40	16	10	10	10	30	60	24	100	40	NO	Practical +Internal
16		17090208	Research Methodology and Statistics	Theory	AECC	2	0	0	2	60	20	20	10	10	40	20											100	40	NO	Theory+Internal
17		17090209	Summer Training (4 weeks)	Practical		0	0	0	4								40	40	80	32	20	20	20	60	120	48	100	40	NO	Theory+Internal
																											200	80	NO	Practical +Internal
18		17090301	Environmental Modeling & Simulations	Theory	Core	3	0	0	3	60	24	20	10	10	40	16														
19		17090302	Soil Chemistry and Solid waste Management	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
20		17090303	Fundamentals of Meteorology and Climatology	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
21	III	17090304	Environmental Modeling & Simulations-Lab	Practical	Core	0	0	4	2																		100	40	NO	Theory+Internal
22		17090305	Soil Chemistry and Solid waste Management- Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	40	100	40	NO	Practical +Internal
23		17090306	Fundamentals of Meteorology and Climatology Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	40	100	40	NO	Practical +Internal
24		17090307	Environmental Impact Assessment and Risk Analysis	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16	20	20	40	16	10	10	10	30	60	40	100	40	NO	Practical +Internal
25		17090308	Open elective Course (University Basket)	Theory	OEC	2	0	0	2	60	24	20	10	10	40	16											100	40	NO	Theory+Internal
																													NO	Theory+Internal
26	IV	17090401	Project Work	Practical		0	0	0	20								80	80	160	64	40	40	40	120	240	96	400	160	No	Practical +Internal
27			**Online Courses during 1st, 2nd and 3rd semesters***						**9**																				No	

*4 week course- 1 credit, 8 week course- 2 credits, 12 weeks course- 3 credits
Every semester a student may opt for either:
One, 12 week course or
One, 4 week course & One, 8 week course or
Three, 4 week courses

Revised

1. Name of the Department : Environmental Science						
2. Course Name	Ecology	**L**	**T**	**P**	**Credits**	
3. Course Code	17090101	3	0	0	3	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)

Lectures = 40	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Ecology is the study of ecosystem. Ecosystem is the interaction between biotic and abiotic components of ecosystems. This course will cover laws controlling some ecological factors &the structural adaptation and functional adjustment of organisms to the changes in physical environment.

9. Course Objectives:

The objectives of this course are:

1. To enumerate the local and geographical distribution of different species.
2. To understand the human interaction with ecological world.
3. To introduce the students with factors responsible for evolution of life.
4. To understand their interactions and natural selection.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand principles of ecology, and predict potentially adverse effect which might happens around them.
2. To understand the relationship of living organisms with their environment.
3. To understand about population and resource dynamics in relation with nature, forests, wild species and climatic factors.
4. To understand population growth and characteristics.

1. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Introduction of Ecology**

Introduction of ecology, origin of life and speciation, evolution. Human ecology and human settlements, Ecology in India, keystone species, ecotypes, Laws of limiting factors – Liebig's law of minimum, Shelford's law of tolerance,

Unit – 2	**Number of lectures = 10**	**Population Ecology**

Population ecology: Characteristics, Concept of carrying capacity, evolutionary strategies r and k selection; population growth. Population Interaction: Competition, mutualism, Adaptations, parasitism and predator prey relations. Ecological Succession.

Unit – 3	**Number of lectures = 10**	**Ecosystem**

Ecosystem: Structural & functional components, Earth's major ecosystems - terrestrial and aquatic ecosystems, Ecosystem stability: Cybernetics and ecosystem regulation. Concept of Productivity.

Unit – 4	**Number of lectures = 10**	**Environmental Factors**

Physicochemical characteristics of environment, Speciation, Concept of Habitat and Ecological Niche, soil microorganisms and their functions, Biology and ecology of reservoirs.

11. Brief Description of self learning / E-learning component

1. https://www.conserve-energy-future.com/what-is-an-ecosystem.php
2. https://www.youtube.com/watch?v=pv-WbXGtkzU

12. Books Recommended

1. Fundamentals of Ecology by Eugene P. Odum, Gary W. Barrett -
   Publisher : Cengage(5 edition)
   ISBN: 9780534420666
2. Ecology and Field Biology by R.L Smith ,
   Publisher: Benjamin Cummings
   ISBN-10 : 0321042905
3. Principles of Environmental Science by William Cunningham and Mary Cunningham
   Publisher: McGraw-Hill Education; 8th edition
   ISBN-10 : 0078036070

1. Name of the Department: Environmental Science						
2. Course Name	**Water Chemistry and Pollution**	**L**	**T**	**P**	**Credits**	
3. Course Code	17090102	3	0	0	3	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Water chemistry aim to develop in students an understanding of the chemical equilibrium and kinetic principles associated with natural and engineered aquatic systems. It helps to develop the capability and confidence in students to solve quantitative chemical equilibrium and kinetic problems in aquatic systems

9. Course Objectives:

The objectives of this course are:
1. To understand some basic concepts of chemistry.
2. To know about solubility and mixing of gaseous and liquid phases.
3. To understand carbonate and bio-carbonate system of water.
4. To know about basic properties of water.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:
1. To understand the basic concepts of thermodynamics.
2. To understand water distribution, water quality and different physico-chemical properties of water.
3. To know about different water quality parameters and their permissible limits.
4. To understand the dynamics of water treatment in both sewage and effluent treatment processes and their practical operation.
5. To get acquainted with Indian monsoon, water distribution and drainage systems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Thermodynamics of Environment**
Law of thermodynamics, Gibb's free energy, Phase equilibrium, solubility product, solubility of gases in water, the carbonate system, solutions: normality, molality and molarity.		
Unit – 2	**Number of lectures = 10**	**Water Chemistry**
Properties of water, water quality parameters: Physical, Chemical & Biological properties, Oxidation-reduction potential (ORP).		
Unit – 3	**Number of lectures = 10**	**Coastal Environment**
Coastal erosion and stabilization, temperature and salinity of ocean water, vertical and horizontal distribution of temp and salinity, composition of seawater and physico -chemical speciation in oceans.		
Unit – 4	**Number of lectures = 10**	**Biochemical Aspects of Water pollution**
Sources, causes and effects of water pollution, characteristics of domestic, industrial and agricultural wastes, chemical and bacteriological sampling and analysis, Marine pollution: thermal pollution. Primary, secondary & tertiary & advance treatment of various effluents.		

12. Brief Description of self learning / E-learning component

1. https://nptel.ac.in/courses/104103020/21
2. https://nptel.ac.in/courses/114106032/
3. https://nptel.ac.in/courses/114105002/9

13. Books Recommended

1. Environmental Chemistry by Stanley Manahan; Stanley E. Manahan
   Publisher : CRC Press
   ISBN-13: 9781420059205
2. Introduction to Environmental Engineering and Science by Gilbert M. Masters; Wendell P. Ela
   Publication
   ISBN-13: 9780131481930
3. Environmental Chemistry by De, A. K.
   Publisher :New Age Publisher International Pvt Ltd
   ISBN : 9789387477247
4. Environmental Chemistry by Manahan, S. E.
   Publisher : CRC Press
   ISBN : 9781498776936
5. Environmental Chemistry by John Wright
   Publisher : Routledge
   ISBN :0-415-22601-5
6. General Climatology by H.J. Critchfield
   Publisher : Pearson
   ISBN : 9789332555242, 9332555249

1. Name of the Department: Environmental Science						
2. Course Name	**Instrumentation and Analytics**	**L**	**T**	**P**	**Credits**	
3. Course Code	17090103	3	0	0	3	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Instrumentations and Analytics help to understand the basic and technical aspects of various instruments and techniques used for environmental analysis such as spectrophotometry, chromatography and chemical titrations etc.

9. Course Objectives:

The objectives of this course are:

1. To acquaint students with advanced micro analysis techniques
2. To differentiate between scanning and Transmission electron microscopes and their use.
3. To be familiar with the most common and advanced analytical techniques.
4. To be acquainted with chromatography techniques.

Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand different environmental monitoring and analysis techniques to choose according to the field study requirement.
2. To get acquainted with different spectroscopy-based techniques and other analytical methods.
3. To understand methods for quantification of different bio molecules.
4. To use various instruments and analytical methods for analysis.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Spectroscopy**

Basic Concepts for Environmental Analysis: Precision, accuracy and error, Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Atomic absorption spectrophotometry, Nuclear magnetic resonance spectroscopy, Electron spin resonance spectroscopy.

Unit – 2	**Number of lectures = 10**	**Chromatography**

Chromatographic techniques, Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography, Gas-liquid chromatography, High pressure liquid chromatography.

Unit – 3	**Number of lectures = 10**	**Microscopy**

Electrophoresis, solid and liquid scintillation, X-ray diffraction. Flame photomtery, Colourimetry, Microscopy-phase, Light and fluorescence microscopes, Scanning and Transmission electron microscopes.

Unit – 4	**Number of lectures = 10**	**Bio-Molecular Techniques**

DNA finger printing, Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, PCR (polymerase chain reaction).

11. Brief Description of self learning / E-learning component

1. https://nptel.ac.in/courses/102103044/28
2. https://nptel.ac.in/courses/103108100/17
3. https://nptel.ac.in/courses/102103017/38
4. https://www.studocu.com/en/document/michigan-state-university/analytical-chemistry/lecture-notes/analytical-chemistry-lecture-notes-lecture-1/493428/view

12. Books Recommended

1.

2 Modern methods of Chemical analysis by Robert L. Pecsok; L. Donald Shields
Publisher :John Wiley & Sons Inc
ISBN-13: 9780471676607

3. Fundamentals of Analytical Chemistry by Douglas A. Skoog; Donald M. West; F. James Holler; Stanley R.
Publisher : Crouch Brooks Cole
ISBN-13: 9780495558286

4. Biophysical chemistry: Principles, techniques, and applications by Alan G Marshall
Publication : Wiley
ISBN-13: 9780471027188

1. Name of the Department: Environmental Sciences						
2. Course Name	Ecology- Lab		**L**	**T**	**P**	**Credits**
3. Course Code	17090104		0	0	4	2
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8. Course Description:

This Course will introduce the students to the basic concept of Ecology and Biodiversity. This course will also give a platform to develop different methods to study population size of an individual organism.

9. Course Objectives:

The objectives of this course are:

1. To study plant community ecology ecosystem.
2. Learn concepts of biodiversity in field.
3. Have knowledge of key methods to study population size.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. Demonstrate fieldwork skills like species identification and ecological survey.
2. To explain the distribution and abundance of different plant species in any region.
3. To evaluate the relationship/interactions among the different species.

11. List of Experiments

1. Determination of minimum size of quadrat for community study.
2. Calculation of the Importance Value Index (IVI) of species.
3. Estimation of chlorophyll content in plant samples.
4. To determine protein content in plant samples.
5. Estimation of biomass of plant sample.
6. Estimation of carbon content in plants.

12. Books Recommended

1. Fundamentals of Ecology by Eugene P. Odum, Gary W. Barrett -
   Publisher : Cengage(5 edition)
   ISBN: 9780534420666
2. Ecology and Field Biology by R.L Smith ,
   Publisher: Benjamin Cummings
   ISBN-10 : 0321042905

1. Name of the Department: Environmental Sciences						
2. Course Name	Water Chemistry and Pollution- Lab		**L**	**T**	**P**	**Credits**
3. Course Code	17090105		0	0	4	2
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8. Course Description:

This Course will introduce the students to the basic concept of water pollution and chemistry. This course will also give a platform to develop different methods to study to various samples of water from various sources.

9. Course Objectives:

The objectives of this course are:
1. Use of practical knowledge and instruments
2. To determine various physico-chemical behaviors of water samples.
3. To measure the residual chlorine present in the water sample

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:
1. To analyze various parameters for water quality assessment like BOD, COD, turbidity etc.
2. To explain the characteristics and relation of different water pollutants.
3. Acquainted with different methods of water quality assessment.

11. **List of Experiments**

1. Determination of Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) in water.
2. Determination of dissolved oxygen (DO) in water.
3. Determination of biological oxygen demand (BOD) of water.
4. To determine chemical oxygen demand (COD) of water.
5. Determination of Total Hardness and alkalinity of water.
6. To determine most probable number (MPN) in given water sample.

12. Books Recommended

1. Environmental Chemistry by Stanley Manahan; Stanley E. Manahan
   Publisher : CRC Press
   ISBN-13: 9781420059205
2. Environmental Chemistry by De, A. K.
   Publisher : New Age Publisher International Pvt. Ltd
   ISBN : 9789387477247
3. Environmental Chemistry by Manahan, S. E.
   Publisher : CRC Press
   ISBN : 9781498776936

1. Name of the Department: Environmental Sciences						
2. Course Name	**Instrumentation and Analytics-Lab**	**L**	**T**	**P**	**Credits**	
3. Course Code	17090106	0	0	4	2	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**SEC ()**			
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52**				

8. Course Description:

Instrumentations and Analytics help to understand the basic and technical aspects of various instruments and techniques used for environmental analysis such as spectrophotometry, chromatography and chemical titrations etc.

9. Objectives

The objectives of this course are :

1. To acquaint with advanced micro analysis techniques
2. To differentiate between principal and working of different instruments
3. To be familiar with the most common and advanced analytical techniques.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand different environmental monitoring and analysis techniques to choose according to the field study requirement.
2. To understand methods for quantification of different bio molecules.
3. To understand the applications of various instruments for analysis of different elements.

11. List of Experiments/ demonstration

1. Demonstration of HPLC
2. Demonstration of GLC
3. Demonstration of AAS.
4. Demonstration of Flame Photometer
5. Demonstration of UV VIS Spectrophotometer.

12. Books Recommended

1. Environmental Chemistry by Stanley Manahan; Stanley E. Manahan
   Publisher :CRC Press
   ISBN-13: 9781420059205
2. Introduction to Environmental Engineering and Science by Gilbert M. Masters; Wendell P. Ela
   Publisher :Pearson
   ISBN-13: 9780131481930
3. Environmental Chemistry by De, A. K.
   Publisher : New Age Publisher International Pvt. Ltd
   ISBN : 9789387477247
4. Undergraduate Instrumental Analysis by James W. Robinson,
   Publisher : CRC Press Fifth Edition
   ISBN : 9780824792152

1. Name of the Department : Environmental Science						
2. Course Name	Environmental Legislations and policies	**L**	**T**	**P**	**Credits**	
3. Course Code	17090107	2	0	0	2	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (✓)**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 26		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course will address the constitutions role and responsibilities of individual, state and central government towards the environment and sustainable development. The course will also familiarize students with vast field of environmental legislations and policies.

9. Course Objectives:

The objectives of this course are to:

1. Explain various laws for environmental protection.
2. Aware students about the scheme of Labelling of environment-friendly products
3. Explain treaties, protocol and conventions related to environment.
4. Sensitize about the role of media and NGOs in environmental protection.
5. Explain schemes and plans for cleaning of major rivers of India.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Understand role of Labels on different instruments.
2. Know about the insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance.
3. Understand duties of individuals for protection of environment.
4. Understand protocols and treaties for solution of different environmental problems.
5. Know rule and regulations for the exploration and use of outer space.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Labeling of products and Laws**

Introduction to Environmental Rules, acts, Laws, Scheme of Labelling of environment-friendly products (Ecomark), Public liability Insurance Act. 1991, Provision of constitution of India regarding environment (article 48 A & 51A).

Unit – 2	**Number of lectures = 6**	**Prevention and control of pollution laws**

Water (Prevention and Control of Pollution)Act,1974;The Air (Prevention and Control of Pollution) Act,1981; The Environmental Protection Act, 1986, Forest & Wildlife Act

Unit – 3	**Number of lectures = 7**	**Environmental conventions and protocols**

Sustainable Development, The Stockholm Declaration, Earth Summit, , Ramsar convention on wetlands, Vienna convention &Montreal Protocol, Kyoto Protocol.

Unit – 4	**Number of lectures = 7**	**Environmental planning**

Ganga Action Plan (1986 and 2014), Yamuna Action Plan, Carbon: credit, trading. Sequestration, ecological footprint, green building, energy audit

12. Brief Description of self-learning / E-learning component

1. https://www.slideshare.net/monaverma1/indian-environmental-legislation
2. https://www.slideshare.net/monaverma1/international-environmental-legislation

13. Books Recommended

1. Environmental Law in India- P. Leelakrishnan,
   Publisher: LexisNexis; Third edition (2010),
   ISBN-13: 978-8180381775
2. Environmental Law Paperback –NishthaJaswal and P.S.Jaswal,
   Publisher: ALLAHABAD LAW AGENCY (2017),
   ISBN-13: 978-8189530303
3. Environmental Planning, Policies & Programmes in India – K.D. Saxena
   Publisher: Shipra Publications
   ISBN-13: 9788185402239
4. Environmental Administration and Law- Paras Diwan.
   Publisher: Deep & Deep Publications,India; 2nd edition (August 1, 2002),
   ISBN-13: 978-8171009763

1. Name of the Department :						
2. Course Name	Professional ethics and human values	**L**		**T**	**P**	**Credits**
3. Course Code	17090108	2		0	0	2
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC (✓)**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course provides students with the knowledge of ethics in professional and social life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family.

9. Course Objectives:

1. To understand Ethics and Universal Declaration on Bioethics and its need.
2. To give due regard to nature and other forms of life by protecting the environment and become socially responsible citizens
3. To inculcate moral and human values for the sustainable growth of the society.
4. To become professionally strong by taking responsibility for what they do in there professional and social life.

10. Course Outcomes (COs):

1. The students will understand the values of ethics and moral values deeply.
2. The students will understand the value of environment and respect for nature.
3. The students will realize the values of responsible citizens to work for the society.
4. The students will be able to take strong decisions and perform their duties responsibly as a professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Introduction to Ethics and Bioethics**

Introduction, Definition, Understanding Ethics,Medical Ethics and Bioethics, History and Development of Ethics, Universal declaration on Bioethics, Need and Importance of professional ethics,

Unit –2	**Number of lectures = 7**	**Title of the unit: Different types of Ethics**

Environmental Ethics,Respect for nature,Respect for culturaldiversity and pluralism.Bio-Safety and Ethical use of animals in the laboratory, Disaster Bioethics,Ethics in Media and Technology, Research Ethics,Ethical Issues in Cyber space.

Unit –3	**Number of lectures = 6**	**Title of the unit: Value of Human Life**

Human Rights and Values: Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity, Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equalitysharing of benefits,

Unit - 4	Number of lectures = 7	Title of the unit: Professional Ethics
Professional Ethics and Public Policy, Goals, Dignity of Labour, Responsibilities towards Safety and Risk, Voluntary vs involuntary Risk, Designing and Research ethics,Privacy, Authorship, Intellectual Property Rights.		

12. Brief Description of self learning / E-learning component

https://www.youtube.com/watch?v=cFOZplkRqsk

https://www.youtube.com/watch?v=Fqt7m8LH5GY

https://www.youtube.com/watch?v=2VYF_t51FyE

https://www.youtube.com/watch?v=9JJykyE2MHw

13. Books Recommended

1. Professional Ethics and Morals by Prof.A.R.Aryasri, Dharanikota Suyodhana – Maruthi Publications.
2. Professional Ethics and Human Values by A. Alavudeen, R.KalilRahman and M. Jayakumaran – University Science Press.
3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

1. Name of the Department : Environmental Science						
2. Course Name	Biodiversity and Conservation		L	T	P	Credits
3. Course Code	17090201		4	0	0	3
4. Type of Course (use tick mark)		Core (✓)	DSE ()		SEC ()	
5. Pre-requisite (if any)	B.Sc.	6. Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40		Tutorials = Nil		Practical = Nil		

8. Course Description:

This course will cover detail understanding of biodiversity pattern and there geographical distribution patterns especially in Indian scenario. It will help in understanding Biodiversity Act, IPRs and provisions for enforcement in preserving the species of different values.

9. Course Objectives:

1. To understand biodiversity pattern and value of biodiversity.
2. To know about various conventions and treaties for biodiversity conservation.
3. To know the common flora and fauna of different regions of India.
4. To know about the working of organizations for wildlife conservation.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. To know about geographical pattern of biodiversity.
2. To know the effect of human civilization and industrialization on biodiversity.
3. To know In-situ and Ex-situ conservation practices.
4. To know about the role of wildlife and ground problems in the protection of local and national wildlife.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Introduction of biodiversity

Introduction of Biodiversity, Historical and geographical pattern of biodiversity; Types of biodiversity, species extinction, values and significance of biodiversity. Threats to biodiversity, levels and gradients of biodiversity.

Unit – 2	Number of lectures = 10	Convention on biodiversity

International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind. Species concept, Biological nomenclature. Theories of biological classification.

Unit – 3	Number of lectures = 10	Biodiversity conservation

Hot spots and cold spots of Biodiversity, strategies for Biodiversity Conservation, Ecologically relevant parameters in conservation , IUCN categories, red data book, green data book

Unit – 4	Number of lectures = 10	NGOs and biodiversity conservation

Biodiversity Act, IPRs, role of WWF, WCU, CITES, TRAFFIC, Wildlife distribution in India. Wildlife and eco-tourism. Problem in wildlife protection. Consequences of monotypic agricultural practice: Case studies. Restoration of biodiversity, acceleration of ecological succession,

reintroduction of biota: case studies.
12. Brief Description of self learning / E-learning component
1- https://nptel.ac.in/courses/102104068/ 2-https://nptel.ac.in/courses/102104068/2 3. https://www.slideshare.net/TalemosSeta/lecture-note-on-biodiversity-conservation 4. https://www.easybiologyclass.com/biodiversity-introduction-definition-classification-importance-measurement-of-biodiversity/
13. Books Recommended
1. Ecology and Environment by PD Sharma Publication :Rastogi Publications (13th Edition) ISBN-13: 978-9350781227 2. Global Biodiversity: Volume 2: Selected Countries in Europe by Apple Academic Press ISBN: 9781771887175 3. Ecology of Natural Resources by Francois Ramade Publisher : John Wiley & Sons Inc ISBN 9780471901044

1. Name of the Department: Environmental Science						
2. Course Name	Environmental Geology and Natural resources		L	T	P	Credits
3. Course Code	17090202		3	0	0	3
4. Type of Course (use tick mark)		Core (✓)	DSE ()		SEC ()	
5. Pre-requisite (if any)	B.Sc.	6. Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)		
Lectures =40	Tutorials = Nil	Practical = Nil

8. Course Description:

Environmental geology is based on the information about different elements in Earth's crust in relation to their availability, essentiality and toxicity. This course will cover basic concepts in geology and detail understanding of knowledge related to oceanic phenomenon and currents. Natural Resources and Disaster Management help in the efficient utilization and conservation of natural resources. This course will cover methods used to prevent suffering include hazard and vulnerability analysis, preparedness, and mitigation and prevention measures

9. Course Objectives:

1. To provide knowledge to students about fundamental concepts in geology, viz. Geological Time Scale, Plate Tectonics, Continental drift etc.
2. To provide information about different elements in Earth's crust in relation to their availability, essentiality and toxicity.
3. To impart knowledge related to oceanic phenomenon and currents; and geo-microbiology.
4. To analyses the risk associated with different disasters and how to predict hazards.
5. To understand approaches of Disaster Risk Reduction (DRR) and the relationship between vulnerability, disasters, disaster prevention and risk reduction.

10. Course Outcomes (COs):

Upon successful completion of this course

1. The student will be able to have detail understanding of oceanic phenomenon and currents.
2. The student will have detail understanding about fundamental concepts in geology.
3. The student will be able to understand Earth's crust in relation to their availability, essentiality and toxicity.
4. To understand effects of hazards, hazard classification natural hazards and technological hazards.
5. To understand management of cyclone, flood, earth quake, drought, disease, fire and volcanic disasters along with forecasting and warning system of disaster.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Basics of geology

Planet Earth: core, mantle, crust, Concept of Geologic Time-Relative dating, absolute dating, the Geological time scale, Basic concepts of plate tectonics type of plate boundaries, plate tectonics and rock cycle. Major rocks: Igneous, sedimentary, metamorphic, ore and minerals

Unit – 2	Number of lectures = 10	Oceanography

Introduction to Oceans, Movements of ocean water: waves, tides and ocean currents, major ocean currents, sea level changes and its impact on coastal areas, oceans as new areas for exploration of mineral resources. Geobiology/geo-microbiology and its applications, concept of bio-mineralization.

Unit – 3	Number of lectures = 10	Disaster management

Disaster management: Nature, cause, effects and management of cyclone, flood, earth quake, drought, disease, fire and volcanism, forecasting and warning system of disaster. Pre- disaster planning, Zoning of disaster prone

areas, prioritization, protection measure during disaster-Post disaster.

Unit – 4	Number of lectures = 10	Energy Resources

Energy Resources of India, Classification of Energy resources, solar, hydroelectric power, tidal power, ocean thermal energy conversion, wind energy, geothermal energy, Biomass energy, Microbial Fuel Cell, Hydrogen as a source of Energy. Nuclear Energy, environmental impacts of different energy resources.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=QDqskltCixA
2. https://www.uvm.edu/~gdrusche/295%20-%20Geomicrobiology.html
3. https://en.wikipedia.org/wiki/Geologic_time_scale
4. https://nptel.ac.in/courses/122102006/9
5. https://nptel.ac.in/courses/105104183/
6. https://crisisequipped.com/

13. Books Recommended

1. Introduction to Geomicrobiology by Kurt O. Konhauser
   Publisher:Wiley-Blackwell
   ISBN :9780632054541
2. Essentials of Oceanography (11th Edition) by Alan P. Trujillo; Harold V. Thurman
   Publisher : Pearson
   ISBN : 9780321814050
3. Soils in Our Environment by Raymond W. Miller; Duane T. Gardiner
   Publisher : Prentice Hall
   ISBN : 9780132191043
4. Ecology of Natural Resources by Francois Ramade
   Publisher : John Wiley & Sons Inc
   ISBN : 9780471901044
5. Natural Resource Conservation: An Ecological Approach by Oliver S. Owen; Daniel D. Chiras
   Publisher : Macmillan Coll Div
   ISBN :9780023901119
6. Environmental Science by William P. Cunningham; Mary Ann Cunningham; Barbara Woodworth Saigo
   Publisher : McGraw-Hill College
   ISBN : 9780073258379
7. Energy Technology (Non Conventional, Renewable and Conventional) by Prof. Sunil S. Rao and Dr. B.B. Parulekar.
   Publisher: Khanna Publisher
   ISBN: 978-81-7409-040-9

1. Name of the Department: Environmental Science						
2. Course Name	**Atmospheric Chemistry and Pollution**	**L**	**T**	**P**	**Credits**	
3. Course Code	17090203	3	0	0	3	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Atmospheric Chemistry and Pollution is based on the information about different processes in Atmospheric chemistry in relation to gases. This course will cover basic concepts in atmospheric chemistry and detail understanding of knowledge related to effect of human activities on the natural atmospheric constitution

9. Course Objectives:

1. To apply basic concepts of chemical thermodynamics, kinetics, and photochemistry to analyze chemical processes existing in atmosphere.
2. To understand the concepts and unifying features of atmospheric chemistry.
3. To understand the interconnections between different layers of atmosphere and the effect of human activities on the natural atmospheric constitution.
4. To understand the sources and harmful impacts of noise pollution on humans and organisms.

10. Course Outcomes (COs):

Upon successful completion of this course the student will be able,

1. To apply the concepts and unifying features of atmospheric chemistry.
2. To understand the interconnections between different layers of atmosphere.
3. To understand the effect of human activities on the natural atmospheric constitution.
4. To understand estimation methods of different air pollutants.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Atmospheric chemistry**

Atmosphere: Chemical composition of atmosphere, Unsaturated and saturated hydrocarbons, Radio nuclides. Chemical processes for formation of inorganic and organic particulate matter. Carnot's cycle, entropy, Adiabatic transformations.

Unit – 2	**Number of lectures = 10**	**Dispersion of pollutants**

Air Pollution: Sources, behaviour and fate of air pollutants, effects of air pollution on human health & materials, Classification and properties of air pollutants, sampling and analysis of air pollutants, Meteorological aspects of air pollutant dispersion, Atmospheric stability, Inversion, Lapse rate, Mixing Height.

Unit – 3	**Number of lectures = 10**	**Air pollution control methods**

Photo-chemical reactions in troposphere, Air pollution control technologies, control of sulphur dioxide from lean and rich waste gases (recovery of sulphur and sulphuric acid); control of NOx through absorption and other newer methods; control of vehicular emission (catalytic conversion devices). Indoor air pollution and its control; Hazardous air pollutants and their management.

Unit – 4	Number of lectures = 10	Noise pollution
Noise Pollution: definition, sound pressure level, noise-spectra, octave bands, combining decibels, Effects of noise pollution, Noise-monitoring, Sound level meter, equivalent continuous noise level and other noise indices, Frequency weighting networks.		
12. Brief Description of self learning / E-learning component		
1. http://acmg.seas.harvard.edu/people/faculty/djj/book/powerpoints/index.html 2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-84j-atmospheric-chemistry-fall-2013/lecture-notes/		
13. Books Recommended		
1. Industrial Noise Control: Fundamentals And Applications, 2Nd Edition by H. Bell; Douglas H. Bell Publisher : T&F India ISBN : 9781138583191 2. Introduction to Environmental Engineering and Science (3rd Edition) by Gilbert M. Masters; Wendell P. Ela Publication : Pearson ISBN : 9780131481930 3. Introduction to Atmospheric Chemistry Publisher: Cambridge University Press ISBN-10: 052177800X ISBN-13: 978-0521778008		

1. Name of the Department: Environmental Sciences						
2. Course Name	Biodiversity & Conservation - Lab		**L**	**T**	**P**	**Credits**
3. Course Code	17090204		0	0	4	2
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8. Course Description:

This Lab work will cover detail understanding of geographical distribution of biodiversity in context to India. This also covers the different methods of biodiversity survey and conservation.

9. Course Objectives:

1. To understand biodiversity distribution and value of biodiversity
2. To know the common flora and fauna of different regions of India.
3. To study different methods of biodiversity conservation.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. To know about geographical distribution of biodiversity on the basis of climatic conditions.
2. To know In-situ and Ex-situ conservation practices.
3. To know about the role of wildlife and ground problems in the protection of local and national wildlife.

11. List of Case Studies / Experiments

1. Various Project and Case studies for the conservation of Wildlife (any two)
2. Study of major National parks, Biosphere reserves and Wildlife Sanctuaries and their Flora and Fauna.
3. Wildlife census method (Waterhole survey, point count and line transect method, pug marks count method).
4. To study the biodiversity present on campus.
5. Biodiversity Photography: Field work.
6. To determine diversity indices in a given area.

12. Books Recommended

1. Ravindra kumar: Fundamentals of Historical Geology and Stratigraphy of India.
2. Krishnan: Geology of India and Burma
3. Wadia: Geology of India.
4. Deshpande G.G.: Geology of Maharashtra

1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Geology and Natural Resources- Lab		**L**	**T**	**P**	
3. Course Code	17090205		0	0	4	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8. Course Description:

Environmental geology and Disaster Management Lab help in the efficient utilization and conservation of natural resources. This course will cover methods used to prevent suffering include hazard and vulnerability analysis, preparedness, and mitigation and prevention measures.

9. Course Objectives:

The objectives of this course are to:

1. To know about the formation and properties of different rocks.
2. To provide information about different elements in Earth's crust in relation to their availability, essentiality
3. To analyse the risk associated with different disasters and how to predict hazards.
4. To aware about role of individuals in hazard control and management.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. To classify and explain differences among different rocks.
2. To understand effects of hazards, hazard classification natural hazards and technological hazards.
3. The student will be able to understand Earth's crust in relation to their availability of various earth resources.

11. List of experiments and Case studies

1. Identification of major rock types.
2. Reading a geological map and the symbols used.
3. Uttarkashi earthquake (Implications and lessons)
4. Flood mitigation practices in India
5. Every student should attend field work for a short duration and submit field diary, geological specimen and a report.
6. Fukushima Daiichi nuclear disaster: Case Study

12. Books Recommended

1. Alan P. Trujillo, Harold V. Thurman - Essentials of Oceanography
   Publisher : Pearson; 12 edition (22 January 2016)
   ISBN-13 : 978-0134073545
2. Ravindrakumar: Fundamentals of Historical Geology and Stratigraphy of India.
   Publisher : NEW AGE; First edition (1 September 2018)
   ISBN-10 : 0852267452
1. D.N Wadia: Geology of India.Publisher Alpha Edition.
   ISBN-13 : 978-9389450620
2. Natural Resource Conservation: An Ecological Approach by Oliver S. Owen; Daniel D. Chiras
   Publisher: Macmillan Coll Div.
   ISBN : 9780023901119

1. Name of the Department: Environmental Science						
2.Course Name	Atmospheric Chemistry and Pollution- Lab	**L**	**T**	**P**		
3.Course Code	17090206	0	0	4		
4.Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5.Pre-requisite (if any)	B.Sc.	**6.Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8.Course Description:

This Course will introduce the students to understand the principle and working of different instruments used for air quality assessment. To know properties of different pollutants and their sampling methodology. To understand the residence and transport of pollutants in atmosphere.

9.Course Objectives:

The objectives of this course are:

1. To know the concentration of Particulate Matter in air.
2. To acquaint with NO_2 measurement procedure.
3. To acquaint with SO_2 measurement procedure.
4. To get familiar with stack monitoring procedure.
5. To understand procedure of noise measurement.

10.Course Outcomes (COs):

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

1. Students will be able to use different instruments for air quality assessment.
2. Students will be able to analyze various parameters for air quality assessment like concentration of NO_2, SO_2, CO, PM etc.
3. Students will also be able to explain the sources of different types air pollutants.

11.List of Experiments

1. Determination of respirable suspended particulate matter (RSPM) in ambient air quality.
2. Determination of NO_2 concentration in ambient air quality.
3. Determination of SO_2 concentration in ambient air quality.
4. Determination of O_3 concentration in ambient air quality.
5. Study of ambient noise level.
6. Stack monitoring and analysis of different pollutants.
7. Determination of Carbon Monoxide.

12.Books Recommended

1. Air pollution by Rao & Rao, Publisher : McGraw Hill Education
   ISBN-13 : 978-0074518717
2. National Ambient Air Quality Series: Central Pollution Control Board

1. Name of the Department: Environmental Science						
2. Course Name	**Environmental Toxicology & Health**	**L**	**T**	**P**	**Credits**	
3. Course Code	17090207	2	0	0	2	
4. Type of Course (use tick mark)	**Core ()**	**DSE ()**		**SEC (✓)**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Semester ()	Every Semester ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 26	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

The course includes knowledge about Occupational Health, Industrial and Environmental Safety, Occupational diseases and their effects, Elements of working conditions. Toxicology involves the study of adverse and harmful effects of chemical substances and physical agents on living things and also on the environment. Pathways of entry, absorption, distribution and excretion of toxic substances into the body play crucial role in toxicology. Students will focus on the application of these concepts to the understanding and prevention of exposure to the chemicals.

9. Course Objectives:

The objectives of this course are:

1. To introduce to occupational health issues and their cause-effect relationships.
2. To know about Industrial and Environmental Safety measures to be taken to reduce health effects.
3. To know the basics occupational health issue management and methodology to reduce the health issues.
4. To know the impacts of occupational environment and stress on the human body and psychology.
5. Identify the different toxic chemicals on the basis of their chemical nature.

10. Course Outcomes (COs):

1. To understand and maintain the physical, mental and social well-being of workers.
2. To understand unfavorable effects on health caused by the working conditions
3. Understand the mechanism of toxicity.
4. Explain the bio-transformation and detoxification mechanisms.
5. Understand the concept of genetic toxicology.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Introduction to toxicology**

Toxicology: Introduction, toxicant hazards, epidemiological issues-goiter, fluorosis, arsenic poisoning. Toxic chemicals in the environment, Mode of entry of toxic substance, Xenobiotics.

Unit – 2	**Number of lectures = 7**	**Control measures for occupational diseases**

Definition of Occupational Health, Need and importance of Industrial and Environmental Safety, Occupational diseases and their effects. Work environment, Stress factor, Fatigue-causes& remedies of fatigue, Elements of working conditions i.e. noise, ventilation, lighting, temperature etc.

Unit – 3	**Number of lectures = 6**	**Dose Responses**

Lethal dose: LD-50, LD-10; dose response, role of geometry in radiation dose, radiation dosimetry, environmental radioactivity, chemical carcinogenicity.

Unit – 4	**Number of lectures = 7**	**Genetic Toxicology**

Carcinogenesis; Carcinogens, chemical carcinogenicity, mechanism of carcinogenicity, Oncogenes and tumour suppressor genes, Mutagens, gene mutation.

12. Brief Description of self learning / E-learning component

1. https://en.wikipedia.org/wiki/Occupational_safety_and_health
2. https://www.who.int/topics/occupational_health/en/
3. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/

4. https://www.britannica.com/science/environmental-toxicology
5. https://www.slideshare.net/gauravhtandon1/environmental-toxicology-32480341

13. Books Recommended

1. Toxicology: Principles and Applications by Raymond Niesink
   Publication :CRC-Press
   ISBN : 9780849392320
2. Ecosystems and Human Health: Toxicology and Environmental Hazards, Third Edition by Richard B. Philp.
   Publication : CRC Press
   ISBN : 9781466567214
3. Occupational Health Hazards and Remedies by R Mohapatra
   Publication : JPB
   ISBN : 9788171799909
4. Occupational Safety and Health by Rosalene E. Graham;Linda S. Rowley
   Publication : Amer Technical Pub
   ISBN : 9780826935700.
5. Environmental hazards & human health R.B. Philip,
   Publisher: CRC Press; 1 edition (April 13, 1995),
   ISBN-13: 978-1566701334
6. Toxicology - principles & applications - Niesink& Jon devries,
   Publisher: CRC-Press; 1 edition (May 29, 1996),
   ISBN-13: 978-0849392320

New

1. Name of the Department: Environmental Science						
2. Course Name	Research Methodology and Statistics	**L**	**T**	**P**	**Credits**	
3. Course Code	17090208	2	0	0	2	
4. Type of Course (use tick mark)	**AEC (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 26	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Research methodology and statistics design to impart basic understanding of fundamental research in Environmental Science. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.

9. Course Objectives:

The objectives of this course are to:

1. Describe basic of research and research projects
2. Promote data analysis methods for research projects
3. Explain types of statistical modelling studies.
4. Learn application of basic statistical software
5. Aware about risks from a developmental project and their characterization

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1.Understand various research methodologies and enable them to carryout research projects

2.Learn statistical methods for data interpretation and analysis

3.Understand basics of mathematics for the modeling studies

4. Learn statistical software.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Introduction to Research**

Objectives-motivation-Significance of research, types of research, Research Methodology, Research and Scientific Method,

Unit-2	**Number of lectures = 10**	**Research Methodology**

Criteria of Good research, selection of research problem, research design, survey literature, hypothesis, sample and sampling, collection, analysis and interpretation of data, research report.

Unit – 3	**Number of lectures = 10**	**Fundamental of Statistics**

Presentation of Data- Frequency distribution and graphical representation, Central test (Mean, Median, Mode), Measurement of Dispersions- Standard Deviation,

Unit – 4	**Number of lectures = 10**	**Statistical Software and Tests**

Probability, Skewness, Statistical analysis using like SPSS, Microsoft Excel and Origin, Testing Hypothesis – Student 't' test, Chi square and Analysis of Variance (F-test)

12. Brief Description of self learning / E-learning component

1. https://nptel.ac.in/courses/121/106/121106007/
2. https://nptel.ac.in/courses/107/108/107108011/

13. Books Recommended

1. Ahuja Ram, Research Methods by Rawath Jaipur.
   Publication: Rawat Publications, Jaipur
   ISBN: 9788170336549
2. Research methods in sociology, Cengage Learning Australia by Babbie Earl,
   Publication: CENAGE Press USA
   ISBN 9781305104945
3. Environmental statistics, methods and applications by Barnett Vic,
   Publication: JhonWiley & Sons NewYork.
   ISBN-13: 978-0471489719
4. Investigating Statistical Concepts, Applications, and Methods by Chance, Beth L.; Rossman, Allan J.
   Publication: Duxbury Press.
   ISBN: ISBN-13: 978-0495050643
5. The good research guide: for small scale social research projects by Denscombe Martyn,
   Publication: Viva Books New Delhi.
   ISBN-13: 978-0495050643

1. Name of the Department: Environmental Science						
2. Course Name	Environmental Modeling & Simulations	**L**	**T**		**P**	**Credits**
3. Course Code	17090301	3	0		0	3
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Environmental modeling, statistics and computer-based data management is essential part of any type of environmental monitoring activity, data analysis, risk assessment and risk mitigation. The use of computer-based modeling is also an integral part of pollution management, weather forecast and disaster management. The course includes use of computer applications in model building and analysis with use of analytical software such as SPSS and origin.

9. Course Objectives:

The objectives of this course are:

1. To learn about the basic role of modelling in prediction of environmental changes.
2. To learn about different stages involved in model building.
3. To get familiar with steady state models used for study of rivers and lakes quality.
4. To know the growth and reaction rates.
5. To learn the use of statistical software in interpretation and analysis.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand various computer-based and statistical methods used for study and management of natural resources and the environment.
2. To understand about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods.
3. To understand different environmental aspects and methodology of formulation of dynamic balance models.
4. To explain the working principle and applications of GIS and GPS.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Introduction of Environmental Modeling**

Sampling methodology, Introduction to environmental sampling; Concept of environmental modeling; Approaches to development of models, Classification of models, Validation and forecasting Modeling techniques.

Unit – 2	**Number of lectures = 10**	**Types of Environmental Modeling**

Model performance, accuracy and utilization; Leslie's matrix model, box model, Gaussian plume model, Response surface methodology. Mass balance model, microbial growth kinetics and Monod equation.

Unit – 3	**Number of lectures = 10**	**Concept of Environmental Informatics**

Lotka-Volterra model of competition, graphical representation of data, MS Office (word, power point, excel etc). Use of Statistical software SPSS and Origin.

Unit – 4	**Number of lectures = 10**	**Environmental Simulations**

Remote sensing system – components and principles – platforms, sensors, medium, target, interactions and their characteristics, concept of GIS & Applications, Basic GIS functions: data inputting methods & various data sources, data management, data manipulation and geographic analysis and output presentation
12. Brief Description of self-learning / E-learning component
1. https://en.wikipedia.org/wiki/Environmental_modelling 2. https://courses.ceu.edu/courses/introduction-environmental-modelling 3. https://www.powershow.com/view/11ff44 ZDk4Y/Environmental_Modeling_Environmental_Modeling_and_Models_powerpoint_ppt_presentation
13. Books Recommended
1. Dynamics of Environmental Bioprocesses-Modelling and simulation - Snape and Dunn. Publisher: Wiley, ISBN 9783527287055. 2. Environmental Modelling – Jorgensen, S. E. Publisher: CRC Press, ISBN 9781566702720 3. Remote sensing and GIS Integration- Qihao Weng. Publisher: McGraw-Hill, ISBN 9780071606547.

1. Name of the Department: Environmental Science							
2. Course Name	Soil chemistry and Solid Waste Management		L	T		P	Credits
3. Course Code	17090302		3	0		0	3
4. Type of Course (use tick mark)		Core (✓)	DSE ()		SEC ()		
5. Pre-requisite (if any)	B.Sc.	6. Frequency (use tick marks)	Even ()	Odd (✓)	Either Semester ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)							
Lectures = 40		Tutorials = Nil		Practical = Nil			

8. Course Description:

The course includes knowledge about weathering of rocks, soil profile, inorganic and organic components of soils, major rock forming minerals, soil/normal forming factors, soil properties, chemical and mineralogical properties of soils. It also includes solid waste management methods-sanitary land-filling, recycling, composting, vermin-composting, incineration, energy recovery from organic waste. The course also includes waste management rules and guidelines with soil contamination from pesticides and fertilizers.

9. Course Objectives:

The objectives of this course are:

1. To know the safe methods of solid waste disposal.
2. To know the methods used for recovery and disposal of solid waste to minimize the adverse effects on environment.
3. To learn the mechanism of composting and Vermi-composting.
4. To know the techniques of producing energy from biomass.
5. To know about management of hazardous waste including corrosive, flammable, explosive and toxic waste.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand the implications of the production, resource management and environmental impact of solid waste management.
2. To understand components of solid waste management infrastructure systems to minimize the above effects.
3. To be familiar with relationships between inappropriate waste management practices and their impacts on water, soil and sediment quality.
4. To understand the solid waste and its environmental implications and to learn about safe methods of solid waste disposal.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Soil properties

Weathering of rocks, Soil profile, Types of soils, Inorganic and organic components of soils, Soil forming factors, Soil properties, Chemical and mineralogical properties of soils.		
Unit – 2	**Number of lectures = 10**	**Solid waste**
Sources, generation, classification &composition of solid wastes. Solid Waste Management-Sanitary land-filling, Recycling, Composting, Vermi-composting, Incineration, Pyrolysis, energy recovery from organic waste, Waste minimization technologies,		
Unit – 3	**Number of lectures = 10**	**Hazardous waste**
Hazardous Waste Management, Sources & Classification, physico-chemical properties, Hazardous Waste Control & Treatment, Hospital Waste Management, Hazardous Waste Management &Handling rules, 1989 &2000 (amendments), Fly-ash generation &utilization.		
Unit – 4	**Number of lectures = 10**	**Soil pollution**
Soil pollution, detrimental effects of soil pollutants, remedial measures for soil pollution, soil sediments as pollutant,		
12. Brief Description of self learning / E-learning component		
1. https://www.environmentalpollutioncenters.org/soil/ 2. https://www.toppr.com/guides/chemistry/environmental-chemistry/soil-pollution/ 3. https://en.wikipedia.org/wiki/Soil_contamination 4. https://www.indiacelebrating.com/environmental-issues/soil-pollution/		
13. Books Recommended		
1. Eco-technology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr. Publisher: Karad, Enviro Media, ISBN 978-81-86421-03-1 2. Basic Environmental Technology - J. A. Nathanson. Publisher: Pearson Prentice Hall; 6 edition, ISBN- 978-0132840149 3. Fundamentals of soil science - Henry D. Foth. Publisher: Wiley India Pvt. Ltd Genre: Science. ISBN9788126562091, 8126562099 4. The Nature and Properties of Soils- Brady, N.C. and Weil, R.R. Prentice-Hall, 14th Edition. Publisher: Pearson, ISBN: 9789332519107, 9332519102		

New

1. Name of the Department : Environmental Science						
2. Course Name	Fundamental of Meteorology and Climatology	**L**	**T**	**P**	**Credits**	
3. Course Code	17090303	3	0	0	3	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**SEC ()**			
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Semester ()	Every Semester ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				
8. Course Description:						
The course provides an introduction of climate change including motions of earth and season's pattern, structure of the atmosphere, different climatological parameters in the formation of clouds and precipitation, air masses and major mechanisms influencing climate.						
9. Course Objectives:						
The objectives of this course are: 1. To know the structure of atmosphere 2. To know the methods used for the study of climate at different environmental condition 3. To learn the mechanism of weather change. 4. To know the monsoon pattern of India 5. To know about cloud pattern and its distribution.						
10. Course Outcomes (COs):						
Upon successful completion of this course, the student will be able: **1.** To understand the weather pattern at different sites. **2.** To understand components and process of climate. **3.** To be familiar with various environmental factors affecting weather conditions **4.** To understand the behavior of monsoon pattern of India.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Fundamental of Climate**				
Latitudes & Longitudes, Motions of the earth: Rotation and Revolution, Coriollis Force, Earth-Sun relationship, Milankovitch Theory, Seasons, Definition of climate, physical factors of climate, classification of climate types, Climate zones of India,						
Unit – 2	**Number of lectures = 10**	**Fundamental of Meteorology**				
Temperature Distribution on Earth & Heat Budget, General circulation, Atmospheric Pressure Belts and Wind Systems, Types of Winds, Fronts and Air Masses, Global weather patterns, Beaufort scale.						
Unit – 3	**Number of lectures = 10**	**Cloud & Monsoon Pattern**				
Clouds, Mechanisms of cloud formation, Types of Clouds, Humidity: Relative Humidity & Dew point, Condensation, Precipitation, Indian Monsoon, Western disturbances						

Unit – 4	Number of lectures = 10	Climatic Disturbances
Thunderstorm and Lightning, Tropical Cyclones, Tornado, Hurricane, El Nino, La Nina, Radiative Forcing, Climate Change, Reducing Green House Gas Emissions,		

12. Brief Description of self learning / E-learning component

1.https://nptel.ac.in/courses/119/106/119106008/https://www.toppr.com/guides/chemistry/environmental-chemistry/soil-pollution/

2.https://nptel.ac.in/courses/119/102/119102007/

13. Books Recommended

1. Climatology-D.S. Lal,
   Publisher: Sharda Pustak Bhawan,
   ISBN 9788186204122
2. Atmosphere, Weather and Climate- Barry R. G. and R. J. Chorley
   Publisher: Routledge.
   ISBN-13 978-0415465700
3. Hand Book of Meteorology- Berry F. A., E. Bollay and N. R. Beers.
   Publisher: McGraw Hill.
   ISBN 13: 9780070050303

1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Modeling & Simulations -Lab	**L**	**T**	**P**	**Credits**	
3. Course Code	17090304	0	0	4	2	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52**				

8. Course Description:

Environmental modeling, statistics and computer-based data management is essential part of any type of environmental monitoring activity, data analysis, risk assessment and risk mitigation

9. Course Objectives:

The objectives of this course are:

1. To learn about the basic role of modelling in prediction of environmental changes.
2. To know different type environmental models.
3. Learn the basics of computer application.
4. To understand the role of modeling in environmental science.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able:

1. To understand various computer-based and statistical methods used for study and management of natural resources and the environment.
2. To understand different environmental aspects and methodology of formulation of dynamic balance models.
3. To understand applications of different environmental models.

11. List of Case Studies / Experiments

1. Application Basic Microsoft Office Software
2. Graphical representation of data
3. Use of statistical package SPSS (Statistical Product and Service Solutions)
4. Graphing in ORIGIN
5. Environmental Modeling software and their applications.

12. Books Recommended

1. Dynamics of Environmental Bioprocesses-Modelling and simulation - Snape and Dunn.
   Publisher: Wiley,
   ISBN 9783527287055.
2. Environmental Modelling – Jorgensen, S. E.
   Publisher: CRC Press,
   ISBN 9781566702720

1. Name of the Department: Environmental Science							
2.Course Name	Soil Chemistry and Solid Waste Management-Lab		**L**	**T**	**P**	**Credits**	
3.Course Code	17090305		0	0	4	2	
4.Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5.Pre-requisite (if any)	B.Sc.	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7.Total Number of Lectures, Tutorials, Practical.							
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**				

8.Course Description:

This Course will introduce the students to understand the basic chemistry of the soil.To know the methodology for analysis of basic physico-chemical properties of soil. To understand the solid waste and its environmental implications.

9.Course Objectives:

The objectives of this course are:

1. To know the principle and working of pH and Electrical conductivity meter.
2. To learn methodology for analysis of Organic carbon content in soil.
3. To learn about the cation exchange capacity of the soil sample.
4. To know the methodology for analysis of sodium and potassium content in the soil sample.
5. To know the types and management strategies of solid waste.

10.Course Outcomes (COs):

Upon successful completion of this course, the student will be able :

1. Students will also able to understand and use different methods and techniques for soil quality analysis.
2. Students will also able to characterize the solid waste on the basis of different properties.
3. Students will also be able determine the heavy metals concentration in soil.

11.List of Experiments

1. Measurement of pH and electrical conductivity of soil.
2. Determination of the organic matter in soil.
3. Determination of cation exchange capacity of the soil.
4. Estimation of exchangeable Na, K, Ca and Mg in soil.
5. Solid waste characterization of the waste in the nearest vicinity.
6. Determination of phosphorus and nitrogen from soil samples.

12.Books Recommended

1. The Nature and Properties of Soils, Brady, N.C. and Weil,
   Publisher: R.R. Prentice-Hall, 14th Edition.
   ISBN: 9789332519107, 9332519102
2. Solid Waste Management CPCB. New Delhi.

New

1. Name of the Department: Environmental Science						
2.Course Name	Fundamentals of Meteorology and Climatology- Lab	**L**	**T**	**P**	**Credits**	
3.Course Code	17090306	0	0	4	2	
4.Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**		
5.Pre-requisite (if any)	B.Sc.	**6.Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52**				

8.Course Description:

The course provides an introduction of climate change including motions of earth and season's pattern, structure of the atmosphere, different climatological parameters in the formation of clouds, and precipitation, air masses and major mechanisms influencing climate.

9.Course Objectives:

The objectives of this course are to:

1. To know the principle and working of weather patterns.
2. To learn methodology for analysis of various meteorological parameters.
3. To know the methodology for analysis of Wind Speed, direction & draw wind rose diagram.
4. To know the types and management strategies for different climatic conditions.
5. To determine and measurement of Rainfall

10.Course Outcomes (COs):

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

1: Students will also able to understand and use different methods and techniques for weather analysis
2: Students will also able to calculate various climatological parameters.
3: Students will also be able analyze monsoon pattern during last 10 years- case study.

11.List of Experiments

1. Measurement of the Atmospheric Temperature and Pressure
2. Measurement of Wind Speed, direction & draw wind rose diagram.
3. Measurement of Rainfall
4. Measurement of Relative & specific humidity.
5. Effect of El Nino on Indian Monsoon – case study
6. Variability in the Monsoon pattern during last 10 years- case study.

12.Books Recommended

1.Statistical methods in Atmospheric Sciences by Daniel S. Wilks, Publisher : Academic Press
ISBN-10 : 0123850223
ISBN-13 : 978-0123850225

2.Time series Analysis and Forecasting by O. D. Anderson, Publisher : Butterworth
ISBN-10 : 0408706759
ISBN-13 : 978-0408706759

3.Statistical Analysis in Climate Research by Hans Von Storch, Francis W. Zwiers
Publisher : Cambridge University Press
ISBN : 0521012309

1. Name of the Department: Environmental Science						
2. Course Name	Environmental Impact Assessment and Risk Analysis	**L**	**T**		**P**	**Credits**
3. Course Code	17090307	2	0		0	2
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (✓)**	
5. Pre-requisite (if any)	B.Sc.	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures = 26		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

EIA (Environmental Impact Analysis) is a process carried out to assess and evaluate the environmental impacts of a proposed project or development, both beneficial and adverse. By using EIA both environmental and economic benefits can be achieved, such as reduction in cleanup and treatment cost by making appropriate changes in project and processes before implementation.

9. Course Objectives:

The objectives of this course are to:

1. Describe basic procedure and details of EIA.
2. Promote environmentally friendly approaches and techniques through identification of alternatives.
3. Explain types of EIA as per the requirement of the project.
4. Explain various analytical and modelling procedures used in EIA.
5. Aware about risks from a developmental project and their characterization

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Use their knowledge to identify the projects which required EIA.
2. Avoid serious and irreversible damage to the environment from developmental projects.
3. Identify key impacts and measures for mitigating adverse impacts of developmental projects on environment.
4. Understand various methods used for risk assessment.
5. Understand that how to prepare EIA report

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Introduction to EIA**

EIA: Introduction, objectives, constraints in EIA, principles and significance; Concept of rapid and comprehensive EIA, Cumulative EIA, EIA notification (MOEF)1994, 2006; Steps of EIA.

Unit – 2	**Number of lectures = 6**	**Methods of Impacts Identification and Mitigation**

Impacts Identification methods (check lists, overlays, Matrices, Models, Comparative studies), Impact evaluation–Cost benefit analysis, methods of monetary evaluation of environmental parameters, multi-criteria approach, mitigation of impacts

Unit – 3	**Number of lectures = 7**	**Environmental Management System**

Public participation in EIA, presentation and review process, Environmental auditing, Environmental Management Plan, Principles of Environmental Management System; ISO 22000:2018, Risk analysis: definition; risk characterization and methods of risk assessment.

Unit – 4	**Number of lectures = 7**	**EIA-Guidelines and Case studies**

EIA of mining industry, nuclear and thermal power plant, textile industry, EIA of a dam (one case study), Environmental clearance of buildings: MOEF guidelines
12. Brief Description of self learning / E-learning component
1. https://www.cbd.int/impact/whatis.shtml 2. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/environmental-impact-assessment
13. Books Recommended
1. Environmental Impact Assessment: Theory and Practice by Anji Reddy Mareddy, Anil Shah, Naresh. Publisher: Butterworth-Heinemann, ISBN-13: 978-0128111390 **2.** Environmental Impact Assessment – John Glasson, Publisher: Routledge; 3 edition (June 6, 2005), ISBN-13: 978-0415338363 **3.** Methods of Environmental Impact Assessment – Morris & Therivel Publisher: Spon Press, ISBN 0-203-99570-8 **4.** Environmental Impact Assessment – L.W. Canter, Publisher: McGraw-Hill Science/Engineering/Math; 2 edition (September 1, 1995), ISBN-13: 978-0070097674 **5.** Chemical Principles of Environmental Pollution – Alloway & Ayers, Publisher: Springer; 2nd edition (November 30, 1993), ISBN-13: 978-0751400137 **6.** Industrial Environment – Assessment and Strategy – S.K. Aggarwal, Publisher: Aph Publishing Corporation, ISBN-13:9789331317971 **7.** Handbook of Environmental Assessment, (Vol.-I & II) – Judith Petts, Publisher: Wiley-Blackwell, Vol-1 ISBN: 978-0-632-04772-7 Vol-2 ISBN: 978-0-632-04773-4