SGT UNIVERSITY
SHREE GURU GOBIND SINGH TRICENTENARY UNIVERSITY
(UGC Approved) Gurugram, Delhi-NCR
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Faculty of Science

M.Sc Environmental Sciences

Syllabus

2019

MASTER OF SCIENCE [M.Sc.]

COURSE ORDINANCE

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning 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.
Faculty of Science. Shree Guru Gobind Singh Tercentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guide lines as such in all PG courses.

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

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. 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 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.

2. GOALS:

i. Employment prospects for post graduates are very good. The scientific knowledge and mathematical and analytic skills acquired help to place across a wide range of industries including aerospace, pharmaceutical, dyes, fabrics, electronics, semiconductors, petroleum, communications, computing, education, commerce, civil services and many more.

ii. The course will build a rich knowledge base to provide a foundation for the continued study of science.

iii. The theoretical and experimental skills necessary to analyze and solve a range of advances problems, providing an excellent foundation for leadership.

iv. Post-graduation leads to abundance of research opportunities.

3. OBJECTIVES

The postgraduate training should enable the student to:

i. Practice efficiently various investigative procedures backed by scientific knowledge including basic sciences and skills.

ii. Get expertise in his/her field of interest

iii. Play the assigned role in the implementation of required practical skills.

iv. Be a motivated 'teacher' - defined as one keen to share knowledge and skills with a colleague or a junior or any learner continue to evince keen interest in continuing education irrespective of whether he/she is in a teaching institution or is practicing and use appropriate learning resources.

v. Exercise empathy and a caring attitude and maintain professional integrity, honesty and high ethical standards.

vi. The student is expected to know his subject in depth; however, emphasis should be on the analytical techniques. Knowledge of recent advances and basic sciences as applicable to his/her specialty should get high priority.

vii. Competence in skills commensurate with the specialty (actual hands-on training) must be ensured.

4. Duration and Nomenclature of the Course:

The duration of M.Sc (Physics /Chemistry /Mathematics /Forensic Science/Envi ronmental Science course shall beof two academic years consisting of four (4) semesters (15- 17 weeks) under Choice Based Credit System(CBCS). On successful completion of all the four semesters, the student will be awarded M.Sc.Degree in the concerned course. The student

shall complete the course within a maximum period of 4 years from the date of admission to the first semester, failing which he/she will be disqualified from the course.

5. Admission to the Course:

i. Eligibility for Admission:

For admission to the 1st Semester of M.Sc. (Physics) course, the candidate must have passed B.Sc. (Pass) with Physics as one of the subjects/B.Sc. (Hons.) Physicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC

For admission to the 1st Semester of M.Sc. (Chemistry) course, the candidate must have passed B.Sc. (Pass) with Chemistry as one of the subjects/B.Sc. (Hons.) Chemistry 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.

For admission to the 1st Semester of M.Sc. (Mathematics) course, the candidate must have passed B.Sc. (Pass) with Mathematics as one of the subjects/B.Sc. (Hons.) Mathematics /B.A (Pass) with Mathematics/ as one of the subjects/ B.A (Hons.) Mathematicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

For admission to the 1st Semester of M.Sc. (Forensic Science) course, the candidate must be graduate with Physics, Chemistry & Mathematics, Physics, Chemistry & Biology OR Agricultural sciences OR BCA OR B.Pharm. OR B.Sc.(Nursing) OR Engineering sciences OR B.Sc.(Forensic Sciences) OR Medical sciences 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.

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) 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.

ii. Schedule of admission and payment of fees:

The admission schedule, along with last date for the submission of admission forms and payment of fees, shall be fixed by the Vice-Chancellor from time to time.

6. Mode of Selection of Candidates for Admission:

The admissions will be made as per the following criteria:

Sr.No.	Criteria	Condition
1	On the Basis of the Merit of the qualifying Examination.	If the no. of applicants is up to 3 times of the intake
2	On the Basis of the Merit of the Entrance Examination.	If the no. of applicants is more than 3 times of the intake

7. Syllabus:

The syllabus is based on Choice Based Credit System (CBCS) and is recommended by Board of Studies and approved by Academic Council from time to time.

8. Scheme of Examination, distribution of marks, credit system and Syllabus:

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as approved by Board of Studies/Academic Council from time to time.

9. Medium of Instruction and Examination:

The medium of the instruction and the examination shall be English only.

10. Attendance Requirements/Eligibility to Appear in Examination:

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examinations:

i. He/she should bear a good moral character.

ii. He/she should be on the rolls of the Dept./Faculty of the University during the semester.

iii. He/she should have 75% of the attendance during the respective semester. Twenty five per cent (25%) of attendance relaxation shall account for illness and contingencies of serious and unavoidable nature.

iv. The Dean of the Faculty of his own or on the recommendation of the HOD shall have the power to give relaxation upto 5% on genuine grounds over the minimum 75% attendance.

v. Further, the Vice Chancellor of his own or on the recommendation of the Dean shall have the power to give further relaxation upto 5% on genuine grounds over the above mentioned minimum attendance.

vi. He/she should not be a defaulter in payment of any dues of the SGT University and no disciplinary action is pending against the student.

11. Exemption from Attendance / Shortage of attendance to be condoned:

The shortage of lecture to the maximum limit as under can be condoned by the competent authority:

Sr. No	Exemptable No. of Lecture	Ground of Exemption	Competent Authority
1	All periods of the days of blood donation	Voluntarily blood donation to the Blood Bank.	Dean of the Faculty
2	All periods of the day of Examination	For appearing in the supplementary examinations(Theory /Practical/Viva-voce)	-do-
3	10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions/ Mountaineering Courses	-do-

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4	15days attendance during a semester	For participation in Inter-University Sports Tournaments/ Youth Festivals	-do-

Provided:

i. that he/she has obtained prior approval of the Dean, Faculty of Science;

ii. that credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

12. Attendance Shortage Warning:

Attendance shortage warning will be displayed on the Faculty's Notice Board and University Website by 10th day of every month.

13. Detained students

A student,who does not fulfill the criteria prescribed in Clauses10-11, will not be eligible for appearing in the End Term Semester Examination in that particular paper and will be deemed as Detained in that paper.Such student will repeat the course/paper alongwith the regular students of the subsequent batchto fulfill the prescribed conditions to appear in the "End Term" examination of the course/ paper.

14. Submission of Examination Forms and Payment of Examination Fee:

The Dean, Faculty of Science shall submit the examination admission forms of thosestudents who satisfy the eligibility criteria to appear in the examinations to the Controller of Examinations as per schedule of examination circulated by him from time to time.

15. University Examinations:

i. End Term Semester Examinations:

The examination for the 1st and 3rd semesters (Odd Semesters) shall ordinarily be held in the month of December and of the 2nd and 4th semesters (Even Semesters) in the month of May/June. The examination dates are fixed by the controller of examination with the approval of Vice Chancellor.

ii. Fail/ Reappear candidates:

Fail / re-appear candidate of the odd semesters (1st & 3rd) will take re-appear exams as an ex-student in the subsequent exams of the odd semesters(1st&3rd). Similarly, for the even semesters (2nd&4th), he/she will take re-appear exams. in the subsequent exams of the even semesters (2nd&4th). However, a candidate appearing in the 4th semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of lower semesters.

16. Improvement Examination:

The student may be permitted to improve his/her result subject to the following conditions:

i. The student will be permitted to appear in improvement examination as an ex-student with regular batches.

ii. The student will be permitted to improve his/her CGPA in one or all papers in which he/she has obtained CGPA less than 'First Division' in aggregate.

iii. Only one chance per paper will be given. The chance must be availed within a year of initially passing of every semester examination.

iv. The candidate will be required to apply and allowed to appear only for theory examinations.

v. If the status/nature of the student's result does not improve by five (05) or more per cent, his/her improvement result will be declared "PRS" (Previous Result Stands).

vi. The candidate shall be allowed to appear in the improvement examination(s) along with regular candidates as and when the course is offered. No separate examination will be held for improvement of result. In case of change of syllabi, the student shall have to appear for improvement in accordance with the changed syllabi of the concerned course applicable to the regular students of that exam.

17. 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.

18. Evaluation Process – Theory and Practical:

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.

Re-evaluation of Answer Books:

Re-evaluation/ rechecking of any paper is allowed. The students can apply for Re-evaluation/ Re-checking of any paper to the Controller of Examinations through the HoD/Dean of the Faculty within 10 days of the declaration of result by paying prescribed fee.

Practical Examinations - Appointment of Examiner:

a. 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.

Marks Distribution:

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

a. Experimental performance = 60% marks
b. Viva-Voce = 30% marks
c. Laboratory work report = 10% marks

19. External Assessment (Summative Assessment):

Sixty per cent marks shall be assigned to each theory and practical paper as Summative Assessment. The distribution of marks in theory as well as practical papers will be in accordance to IQAC guidelines.

20. Internal Assessment(Formative Assessment):

i. (Theory Papers)

a. Based on 40 Marks:

1	Assignment	5 marks
2	Mid Term Test (10 Marks each)	20 marks
3	Synergy / Project	10 marks
4	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

b. Based on 20 Marks:

1	Assignment	5 marks
2	Mid Term Test	10 marks
3	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

i. (Practical/Project/Dissertation)

i. Based on 40 Marks:

S.no.	40 Marks Internal		60 Marks External
1	Attendance	10 marks	
2	Practical/Project	10 marks	

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	File/Dissertation		30 marks for Practical examination (Conduction/ Demonstration)/Project File/Dissertation + 30 marks for Viva-Voce in End-term Examination by External Experts.
3	Internal Viva-Voce	20 marks	
	Marks distribution for Attendance in % age		
	97.5<=Attendance=100	10 marks	
	95<=Attendance<97.5	9 marks	
	92.5<=Attendance<95	8 marks	
	90<=Attendance<92.5	7 marks	
	87.5<=Attendance<90	6 marks	
	85<=Attendance<87.5	5 marks	
	82.5<=Attendance<85	4 marks	
	80<=Attendance<82.5	3 marks	
	77.5<=Attendance<80	2 marks	
	75<=Attendance<77.5	1 Marks	

ii. Based on 20 Marks:

s.no.	20 Marks Internal		30 Marks External
1	Attendance	5 marks	15 marks for Practical examination (Conduction/ Demonstration)/Project file/Dissertation + 15 marks for Viva-Voce in End-term Examination by External Experts.
2	Practical/Project File/Dissertation	5 marks	
3	Internal Viva-Voce	10 marks	
	Marks distribution for Attendance in % age		
	95<=Attendance=100	5 marks	
	90<=Attendance<95	4 marks	
	85<=Attendance<90	3 marks	
	80<=Attendance<85	2 marks	
	75<=Attendance<80	1 Marks	

iii. In case of ex-students, those appearing for re-appear / improvement examination in any semester, their previous Internal Assessment marks will be counted. If there is any change in Scheme of Examination, then Internal Assessment marks will be modified accordingly.

iv. The concerned teacher shall preserve records on the basis of which the Internal Assessment has been awarded and shall make the same available to the Controller of Examinations whenever required.

v. The Head of the Department/ Dean of the Faculty shall ensure:

a. That the internal assessment marks are displayed for information of the students at least seven (07) days before the commencement of the examinations of each semester

b. That the internal assessment marks are submitted to the Controller of Examinations at least seven (07) days before the commencement of the examinations of each semester.

21. Criteria for Promotion to Higher Semester:

The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2nd to 3rd Semester, the student shall have to clear at least 50% papers of 1st and 2nd semesters taken together.

22. Credit Based Grading System:

i. Key Definitions:

Programme	An educational programme leading to award of a Degree, Diploma or Certificate.
Course	Usually referred to as 'paper' is a component of a programme. All courses need not carry the same weight.
Credit	A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for practical work/field work per week. A Research Based Paper /Project is equal to 6 credits.
Credit Point	It is the product of grade point and number of credits for a course i.e. Credit Point = No. of credits in a course X "grade value" of the grade obtained in the course.
Grade Point	There are two types of GPAs as given hereunder:
Average (GPA)	Semester Grade Point Average (SGPA) Cumulative Grade Point Average (CGPA) Every student earns a distinct SGPA and a distinct CGPA at the end of each specified semester.
SGPA	SGPA is a measure for performance of student in a Semester. It is the Point Average ratio of sum of the product of number of credits with the grade points scored by the student in all the courses taken by him/her and the sum of the number of credits of all the Courses undergone by the student i.e. SGPA (Si) =∑(CixGi) /∑Ci
CGPA	CGPA is a measure of performance up to any Grade Gradespecified semester Point Average beginning from the first Semester. It is also calculated in the same (CGPA) manner as SPGA taking into account all the courses undergone by a student over all the semesters of programme i.e. CGPA = ∑(Cix Si) / ∑Ci
Grade Point	Itis a numerical weight allotted to each letter grade on a 10-point scale.
Letter Grades	It is an index of the performance of a student in a said course. The Grades are denoted by letters O, A+, A, B+, B, C, P, F and Ab.

ii. Credits, Semesters, Courses and total Credit Points:

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S.No	Course	Semesters	Core Courses	Discipline Specific elective Courses	Skill Enhancement Courses	Total Credits
1	M.Sc.(Physics)	4	72	16	12	100
2	M.Sc.(Chemistry)	4	74	12	14	100
3	M.Sc.(Mathematics)	4	78	12	10	100
5	M.Sc.(Forensic Sciences)	4	86	8	6	100
6	M.Sc.(Environmental Science)	4	60	24	16	100

Grading Table

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8< 9	Excellent
70 & above but less than 80	A (Very Good)	8	7< 8	1st Div with Distinction
60 & above but less than 70	B+ (Good)	7	6< 7	1st Division
50 & above but less than 60	B (Above Average)	6	5<6	2nd Division
Above 40 but less than 50	C (Pass Average)	5	Above 4 <5	3rd Division
40	P(Pass)	4	4	Pass
Less than 40	F (Fail)	0	-	Fail

Formula for Calculating percentage of marks:

CGPA× 10 e.g. 6.53× 10 = 65.3

Formula for Grade Point calculation:

G = (Marks Obtained in Paper/Total marks of paper) x100.

Formula for Computation SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grad points scored by a student in all the courses taken by a students and the sum of the number of credits of all the courses taken by the students;

i.e SGPA (Si) = $\sum(Ci \times Gi) / \sum Ci$,

where Ci is the no of credits of the ith course and Gi is the grad point Scored by the student in the ith course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by the students over all the students over all the semesters of a programme , i.e

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded up to 2 decimal points and reported in the transcripts. Result–Cum-Detailed Marks Card/ Transcript: Based on the above recommendations on letter grades, grade points and SGPA and CGPA, the DMC/ Transcript for each semester and a consolidated transcript in dictating the performance in all semester may be issued

iv. **1. Illustration of Computation of SGPA and CGPA and Format for Transcripts**

Course	Credit	Grade Letter	Grade Point	Credit Points (Credit × *Grad*)
Course 1	3	A	8	3×8 = 24
Course 2	4	B +	7	4×7 = 28
Course 3	3	B	6	3×6 = 18
Course 4	3	O	10	3×10 = 30
Course 5	3	C	5	3×5 = 15
Course 6	4	B	6	4×6 = 24
	20			**139**

Thus, SGPA = 139/20 = 6.95

Similarly, Suppose the SGPA for 2nd , 3rd and 4th semester are 7.85 , 5.6, and 6.0 with credits 22, 24 and 22, respectively, then for a two-year PG Programme, the CGPA will be computed as followed,

CGPA = (20× 6.95 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.57

Course	Credits	Grade Letter	Grad Point Block	Range of Grad Points(Actual Grade Value as per marks obtained	Earned Credit Point(Credit × Actual *Grade Value*)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=27.6
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				**135.9**

Thus, SGPA= 135.9/20 = 6.79

Similarly suppose SGPA for 2nd , 3rd , and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24, and 22 respectively

CGPA = (20× 6.79 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.53

Calculating percentage of marks

CGPA× 10 E.G.6.53× 10 = 65.3

23. Pass criteria:

The minimum percentage of marks to pass the examination in each subject/paper will be 40% each in theory paper, practical /field work/Research Project etc. examination & internal assessment. The student has to pass in summative and formative (Internal) assessment separately.

24. 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.

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)

Course Structure under Choice Based Credit System (CBCS): 2019-2020

SEMESTER	COURSE CODE	Core/ AECC/ SEC/ DSE/ GE	COURSE NAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
I	17090101	(CC)	Ecology	4	0	0	4	4	100	40	60
	17090102	(CC)	Instrumentation and Analytics	4	0	0	4	4	100	40	60
	17090103	(CC)	Water Chemistry and Pollution	4	0	0	4	4	100	40	60
	17090104	(DSE)	Environmental History & Contemporary Policies	4	0	0	4	4	100	40	60
	17090105	(DSE)	Natural resources and Disaster Management	4	0	0	4	4	100	40	60
	17090106	(SEC)	Professional Ethics and Human Values	2	0	0	2	2	50	20	30
	17090107	(CC)	Ecology -Lab	0	0	4	4	2	50	20	30
	17090108	(CC)	Instrumentation and Analytics-Lab	0	0	4	4	2	50	20	30
	17090109	(CC)	Water Chemistry and Pollution-Lab	0	0	4	4	2	50	20	30
	17090110	(DSE)	Environmental History & Contemporary Policies- Practical & research work	0	0	4	4	2	50	20	30
	17090111	(DSE)	Natural resources and Disaster Management- Practical & research work	0	0	4	4	2	50	20	30
Total Credits				**18**	**0**	**16**	**34**	**26**	**650**	**260**	**390**
II	17090201	(CC)	Microbial Biotechnology	4	0	0	4	4	100	40	60
	17090202	(CC)	Stress Physiology	4	0	0	4	4	100	40	60
	17090203	(CC)	Atmospheric Chemistry and Pollution	4	0	0	4	4	100	40	60
	17090204	(DSE)	Environmental Geology	4	0	0	4	4	100	40	60
	17090205	(DSE)	Biodiversity Conservation	4	0	0	4	4	100	40	60
	17090206	(SEC)	Occupational Health & Safety	2	0	0	2	2	50	20	30
	17090207	(CC)	Microbial Biotechnology - Lab	0	0	4	4	2	50	20	30
	17090208	(CC)	Stress Physiology- Lab	0	0	4	4	2	50	20	30
	17090209	(CC)	Atmospheric Chemistry and Pollution- Lab	0	0	4	4	2	50	20	30
	17090210	(DSE)	Environmental Geology- Practical & research work	0	0	4	4	2	50	20	30
	17090211	(DSE)	Biodiversity Conservation- Practical & research work	0	0	4	4	2	50	20	30
Total Credits			**Core Courses**	**18**	**0**	**16**	**34**	**26**	**650**	**260**	**390**

III	17090301	(CC)	Environmental Modeling, Computer and Statistics	4	0	0	4	4	100	40	60
	17090302	(CC)	Soil Chemistry and Solid waste Management	4	0	0	4	4	100	40	60
	17090303	(DSE)	Social Issues & Environment	4	0	0	4	4	100	40	60
	17090304	(DSE)	Agriculture and Environment	4	0	0	4	4	100	40	60
	17090305	(CC)	Environmental Modeling, Computer and Statistics Lab	0	0	4	4	2	50	20	30
	17090306	(CC)	Soil Chemistry and Solid waste Management- Lab	0	0	4	4	2	50	20	30
	17090307	(DSE)	Social Issues & Environment- Practical & research work	0	0	4	4	2	50	20	30
	17090308	(DSE)	Agriculture and Environment- Practical & Research wrok	0	0	4	4	2	50	20	30
	17090309	(SEC)	Industrial Training & Report	0	0	2	2	4	100	40	60
	17090310	(SEC)	Field survey	0	0	2	2	2	50	20	30
Total Credits				**12**	**0**	**16**	**28**	**24**	**600**	**240**	**360**
IV	17090401	(CC)	Environmental Impact Assessment and Risk Analysis	4	0	0	4	4	100	40	60
	17090402	(CC)	Environmental Toxicology and Health	4	0	0	4	4	100	40	60
	17090403	(DSE)	Environmental Economics	4	0	0	4	4	100	40	60
	17090404	(DSE)	Environmental Legislations and Awareness	4	0	0	4	4	100	40	60
	17090405	(CC)	Environmental Impact Assessment and Risk Analysis- Lab	0	0	4	4	2	50	20	30
	17090406	(CC)	Environmental Toxicology and Health- Lab	0	0	4	4	2	50	20	30
	17090407	(DSE)	Environmental Economics Practical and Research work	0	0	4	4	2	50	20	30
	17090408	(DSE)	Environmental Legislations and Awareness- Practical and Research work	0	0	4	4	2	50	20	30
	17090409	(SEC)	Dissertation	0	0	12	12	6	150	60	90
Total Credits				**12**	**0**	**24**	**36**	**24**	**600**	**240**	**360**
			Grand Total	**60**	**0**	**72**	**132**	**100**	**2500**	**1000**	**1500**

1. Name of the Department : Environmental Science							
2. Course Name	Ecology		**L**		**T**		**P**
3. Course Code	17090101		4		0		0
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 = 60		**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 to:

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 population growth and characteristics
5. To understand their interactions and natural selection.

10. Course Outcomes (COs):

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

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.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction of Ecology**

Introduction of ecology, origin of life and speciation, evolution. Human ecology and human settlements, Ecology in India, Community Organization: Analytic and synthetic characters, Concept of niche, keystone species, ecotypes, plant indicators.

Unit – 2	**Number of lectures = 15**	**Laws of Ecology**

Laws of limiting factors – Liebig's law of minimum, Shelford's law of tolerance, Population ecology: Characteristics, Concept of carrying capacity, evolutionary strategies r and k selection; population growth. Population Interaction: Competition, Lotka-Volterra equations, mutualism, Adaptations, parasitism and predator prey relations. Ecological Succession: Types, trends and models, concept of climax.

Unit – 3	**Number of lectures = 15**	**Ecosystem**

Ecosystem: Structural components, ecological pyramids, food webs, trophic levels, ecological efficiencies, models of energy flow, Ecosystem stability: Species diversity, Stability, Cybernetics and ecosystem regulation. Primary and secondary production, methods of measuring primary productivity.

Unit – 4	**Number of lectures = 15**	**Coastal Ecology and Biogeochemical cycles**

Biogeochemical cycles, gaseous and sedimentary cycles- carbon cycle, nitrogen cycle, sulphur cycle and phosphorus cycle. Earth's major ecosystems - terrestrial and aquatic ecosystems, soil microorganisms and their functions, Coastal management, Biology and ecology of reservoirs.

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

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

13. Books Recommended

1. Fundamentals of Ecology-Eugene P. Odum, Gary W. Barrett
2. Ecology and Environment- PD Sharma
3. Animal Ecology and Environmental Biology- H.R. Singh
4. Fundamental of Ecology- S.K Aggrawal

1. Name of the Department : Environmental Science						
2. Course Name	**Instrumentation and Analytics**		**L**	**T**		**P**
3. Course Code	17090102		4	0		0
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 = 60		**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 to:

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.
5. To be familiar with the most common and advanced biotechnologies.

Course Outcomes (COs):

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

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

10. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Spectroscopy**

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

Unit – 2	**Number of lectures = 15**	**Ch romatography**

Chromatographic techniques, Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography, Gas-liquid chromatography, High pressure liquid chromatography, Cytophotometry and flow cytometry, Ultracentrifugation, Titrimetry, Gravimetry,

Unit – 3	**Number of lectures =15**	**Microscopy**

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

Unit – 4	**Number of lectures = 15**	**Bio-Molecular Techniques**

Methods for measuring nucleic acid and protein interactions, DNA finger printing, Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, PCR (polymerasechain 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. Undergraduates Instrumental Analysis- James W. Robinson
2. Modern methods of Chemical analysis- Robert, Shields, Cairns, William.
3. Fundamentals of Analytical Chemistry 8th Edition- Skoog, West, Holler and Crouch, Cengage Learning India.
4. Principles & techniques of biochemistry and molecular biology- Keith Wilson and John Walker
5. Biophysical chemistry: Principles & techniques- Upadhyay, Upadhyay, Nath

1. Name of the Department : Environmental Science							
2. Course Name	**Water Chemistry and Pollution**		**L**		**T**		**P**
3. Course Code	17090103		4		0		0
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 = 60	**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 help 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 to:
1. To understand some basic concepts of chemistry.
2. To understand the basics of thermodynamics.
3. To know about solubility and mixing of gaseous and liquid phases.
4. To understand carbonate and bio-carbonate system of water.
5. To know about basic properties of water.

10. Course Outcomes (COs):

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

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Thermodynamics of Environment**

Concept and scope, basic understanding of thermodynamics of environment, Gibb's free energy, chemical potential, phase equilibrium, stochiometry, acid base reactions, solubility product, solubility of gases in water, the carbonate system, solutions: normality, molality and molarity, expressing concentrations.

Unit – 2	**Number of lectures = 15**	**Water Chemistry**

Properties of water, water quality parameters: Physical, Chemical & Biological parameters, DO, BOD, COD, salinity, pH, Electrical Conductivity, Oxidation-reduction potential (ORP), Environmental setting of India: Structure and relief, drainage system and watersheds, mechanism of Indian monsoon and rainfall patterns, floods and droughts, floods and droughts.

Unit – 3	**Number of lectures = 15**	**Coastal Environment**

Coastal environment, coastal erosion and stabilization, relief of the ocean floor, 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 = 15**	**Biochemical Aspects of Water pollution**

Sources, consequences, ecological and biochemical aspects of water pollution, characteristics of domestic, industrial and agricultural wastes, their effects on water bodies, chemical and bacteriological sampling and analysis, Marine pollution: thermal pollution. Primary, secondary & tertiary & advance treatment of various effluents. Pesticides in water

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/1 14105002/9
13. Books Recommended
1. Environmental Chemistry-Manahan & Manahan 2. Environmental Chemistry-Sharma &Kaur 3. Introduction to Environmental Engineering & Science- Gilbert Masters 4. Environmental Chemistry- A.K. DE

Removed

1. Name of the Department : Environmental Science						
2. Course Name	Environmental History & Contemporary Policies	**L**	**T**	**P**		
3. Course Code	17090104	4	0	0		
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, Practicals (assuming 15 weeks of one semester)						
Lectures = 60	**Tutorials = 0**	**Practical = 0**				

8. Course Description:

The course will help students to understand about the history of the Earth in context of connection of people and environment.
It will also help to understand different trends in the past related to resource use and environmentalism.
It will help to understand the connection between policy making and environment.

9. Course Objectives:

The objectives of this course are to:

1. Understand the history of the Earth in context of connection of people and environment.
2. Have knowledge of policies and their impacts on the environment.
3. Learn the role of people in the conservation and deterioration of the environment.
4. To understand the ancient methods of environmental conservation.

10. Course Outcomes (COs):

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

1. Understand the history of the Earth in context of connection of people and environment.
2. Develop an understanding towards human history and environmental impacts.
3. Have knowledge of policies and their impacts on the environment.
4. Learn the role of people in the conservation and deterioration of the environment.

Unit wise detailed content

Unit – 1	**Number of lectures = 15**	**Ancient History**

Introduction to the ideology of environmentalism and environmental history, Modern environmental movements. The Gaia theory. History of the development of environmental history as a discipline and its relationship with social and economic history. Methods and Sources of Environmental History: Distributions from other types of history.

Unit – 2	**Number of lectures = 15**	**Environmental History**

Environmental History as Natural History: In the developed and developing nations. Environmental History as a History of Industrialization and Anti-Industrialization: debates on the nature of modernization and industrialization in developed and developing countries. Issues of its links with history of science and technology.

Unit – 3	**Number of lectures = 15**	**European rise and colonialism**

The Rise of European power and its consequences not only for peoples, but also for plants and pathogens, animals and landscapes. Nature and Empire: Debate on 'colonialism as a watershed'. Colonialism and the unleashing of destructive forces and the threat of general environmental decline.

Unit – 3	**Number of lectures = 15**	**Contemporary Ideas**

Ideas of wilderness and conservation. Environmental History as the History of the State: State and state policy, Environmental History and Marginalized People: Issues of castes, identity politics and ethnicity
Environmental History as a Global History: Challenges posed by globalization

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

1. https://www.eh-resources.org/
2. https://enviroliteracy.org/teaching-resources/environmental-history-modules/
3. http://www.nea.org/tools/lessons/63302.htm

12. Books Recommended

1. Arnold, David & Guha, Ramachandra (Ed.), 1995, Nature, Culture, Imperialism: Essays on the
2. Environmental History of South Asia, Oxford University Press, Delhi.
3. Baviskar Amita, 2003, 'Tribal Discourse and Indian environmentalism in Greenough, Paul and Anna
4. Lowenhapept Tsing (Ed.), Nature in the Global South: Environmental Projects in South and Southern
5. Asia, Durham and, London: Duke University Press/Orient Longman.
6. Balee William, 1998, Advances in Historical Ecology, Columbia University Press, New York.
7. Beinart William and Coates Peter, 1995, Environment and History, London: Routledge.
8. Carson, Rachel, 1962, Silent spring. Houghton Miflin, Boston.

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1. Name of the Department : Environmental Science						
2. Course Name	**Natural Resources and Disaster Management**	**L**	**T**	**P**		
3. Course Code	17090105	4	0	0		
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 = 60	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

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:

The objectives of this course are to:

1. To know the basics of energy sources.
2. To know about the chemical characteristics of different fossil fuels.
3. To understand the technical aspects of different energy generation technologies.
4. To understand the adverse environmental effects of mining and mineral processing.
5. To analyse the risk associated with different disasters and how to predict hazards.

10. Course Outcomes (COs):

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

1. To understand and distinguish among different resources with their benefits, adverse impacts on environment, availability, use and energy generation processes.
2. To understand the environmental impact of exploitation, processing and smelting of minerals; and overuse of mineral reserves.
3. To understand effects of hazards, hazard classification natural hazards and technological hazards.
4. 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 = 15**	**Energy Source**

Sun as a source of energy, solar radiations and its spectral characteristics, classification of fossil fuels, calorific values of different fossil fuels, principles of generation of hydroelectric power, tidal power, ocean thermal energy conversion, wind energy, geothermal energy, solar collectors, photovoltaic, solar ponds.

Unit – 2	**Number of lectures = 15**	**Mineral Resources**

Mineral resources and reserves, ocean ore and recycling of resources, Environmental impacts of mineral exploitation, processing and smelting of mineral, ocean as area for exploitation of mineral resources.

Unit – 3	**Number of lectures = 15**	**Natural Hazards**

Hazard Classification–Natural hazards and Technological hazards, Effects of hazards, Assessing hazards and risks, Hazard prediction and warning, Role of individuals, agencies, governmental and local bodies; Natural service functions of natural hazards. A brief introduction to biological hazards- Forest fires, Biological warfare,

Unit – 4	**Number of lectures = 15**	**Natural Disaster Management**

Natural 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.

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

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1. https://nptel.ac.in/courses/122102006/9
2. https://nptel.ac.in/courses/105104183/

13. Books Recommended

1. Natural Resources conservation-Oliver S Owen &Chiras
2. Living in the Environment –T.J.Miller
3. Environmental Science- Cunningham Sai go
4. Ecology of Natural Resources-Ramade
5. Global Biodiversity-W.R.L. IUCN
6. Soils-Miller, W & R.L. Donhau

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1. Name of the Department : Environmental Science						
2. Course Name	Professional ethics and human value	**L**		**T**	**P**	
3. Course Code	17090106	2		0	0	
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 = 30		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course provides students with the knowledge of ethics in professional 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 develop ethical and human values in students
2. To develop the responsibility in students at professional and societal levels.

10. Course Outcomes (COs):

1. The students will understand the values of professional ethics and moral values deeply.
2. The students will be able to take strong decisions and perform their duties responsibly as on professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Ethics and Human Values**

Definition, History and Development of Ethics, Universal declaration on Bioethics, ,Theories related to Bioethics: Utilitarian theory, Deontological theory and Communication theory.
Human Rights and Values : Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity
Environmental Ethics, Animal ethics

Unit –2	**Number of lectures = 15**	**Title of the unit: Professional Ethics & Responsibility**

Need and Importance of professional ethics, Goals, Dignity of Labour, IRB & its functions, Authorship

Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality

Responsibilities towards Safety and Risk, Voluntary v/s In voluntary Risk, Designing/Research for Safety – Risk, Benefit Analysis, Accidents. Disaster ethics,

Ethics in Media and Technology, Research Ethics, Intellectual Property Rights.

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

1. https://www.youtube.com/watch?v=cFOZplkRqsk&authuser=2
2. https://www.youtube.com/watch?v=HJk1Eodmf9A&authuser=2
3. https://www.youtube.com/watch?v=Fqt7m8LH5GY&authuser=2
4. https://youtu.be/2VYF_t51FyE
5. https://youtu.be/hjzA_rZG-bU

13. Books Recommended

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

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1. Name of the Department: Environmental Sciences						
2. Course Name	Ecology- Lab		**L**	**T**		**P**
3. Course Code	17090107		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 = 60**			

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 to

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 to:

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. Determination of density, frequency, abundance, and dominance of plant species using quadrat method
3. Calculation of the Importance Value Index (IVI) of species.
4. Estimation of chlorophyll content in plant samples
5. To determine protein content in plant samples.
6. Estimation of biomass of plant sample.

12. Books Recommended

1. Basic ecology - E. P. Odum
2. Ecology and Field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff

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1. Name of the Department: Environmental Sciences						
2. Course Name	**Instrumentation and Analytics-Lab**	**L**	**T**	**P**		
3. Course Code	17090108	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 = 60**				

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 to:

1. To acquaint 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.

10. Course Outcomes (COs):

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

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

11. List of Experiments

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. Undergraduates Instrumental Analysis- James W. Robinson
2. Modern methods of Chemical analysis- Robert, Shields, Cairns, William.
3. Fundamentals of Analytical Chemistry 8th Edition- Skoog, West, Holler and Crouch, Cengage Learning India.

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1. Name of the Department: Environmental Sciences						
2. Course Name	Water Chemistry and Pollution- Lab		**L**	**T**	**P**	
3. Course Code	17090109		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 = 60**

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 to:

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 to:

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) 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 Dissolved Solids (TDS), hardness and alkalinity of water.
6. To determine most probable number (MPN) in given water sample.

12. Books Recommended

1. Environmental Chemistry-Manahan & Manahan
2. Environmental Chemistry-Sharma &Kaur
3. Introduction to Environmental Engineering & Science- Gilbert Masters
4. Environmental Chemistry- A.K. DE

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1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental History and Contemporary Policies- Lab		**L**	**T**	**P**	
3. Course Code	17090110		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 = 60**			

8. Course Description:

Environmental history Lab will help in the study of human interaction with the natural world over time, emphasizing the active role nature plays in influencing human affairs and vice versa.

9. Course Objectives:

The objectives of this course are to:

1. To know about the role and place of nature in human life
2. To aware about the how biophysical world has influenced the course of human history.
3. To analyse the human and environmental factors in the creation of landscapes

10. Course Outcomes (COs):

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

1. To understand the correlation between nature and human development.
3. To understand management of human civilization.

11. List of Case Studies

1. Industrialization in India: Case study
2. European Colonialism and Natural Resources Exploitation: Indian Case Study
3. Environment & Politics in India: Case Study
4. Water Conservation in Ancient India: Case studies
5. Sanitation practices and techniques in Ancient Rome
6. Past traditions in Indian culture for environmental conservation

12. Books Recommended

1.An Environmental History of India: From Earliest Times to the Twenty-First Century (New Approaches to Asian History)- Michael H. Fisher

2. History of Ancient India. K. Sagar Publications

3. Indus Civilization. D.P Aggrawal. Aryan Book Depot, 2017

1. Name of the Department: Environmental Sciences							
2. Course Name	Natural Resources and Disaster Management- Lab		**L**		**T**		**P**
3. Course Code	17090111		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 = 60**				

8. Course Description:

Natural Resources 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 chemical characteristics of different fossil fuels.
2. To aware about the benefits of renewable energy
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 understand effects of hazards, hazard classification natural hazards and technological hazards.
3. To understand management of cyclone, flood, earth quake, drought, disease, fire and volcanic disasters along with forecasting and warning system of disaster.

11. List of Case Studies

1. Uttarkashi earthquake (Implications and lessons),
2. Latur (Killari) earthquake experiences.
3. Flood mitigation practices in India
4. To identify the locations of renewable and non-renewable resources in India and at global level
5. Disaster Management Plan of Flood special reference to Badrinath Disaster
6. Fukushima Daiichi nuclear disaster: Case Study

12. Books Recommended

1. Natural Resources conservation-Oliver S Owen &Chiras
2. Living in the Environment –T.J.Miller
3. Environmental Science- Cunningham Saigo
4. Ecology of Natural Resources-Ramade
5. Global Biodiversity-W.R.L. IUCN
6. Soils-Miller, W & R.L. Donhau

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1. Name of the Department : Environmental Science						
2. Course Name	Microbial Biotechnology		**L**	**T**	**P**	
3. Course Code	17090201		4	0	0	
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 = 60	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Environmental Biology is based on the interaction of Proteins, Nucleic acids and amino acids at molecular level in microorganisms and their fate in environment degradation. This course will cover basic principles and detail understanding of biotechnology in relevance to different methods, which will include genetic engineering, bioremediation, and enzyme technology and soil microbiology.

9. Course Objectives:

The objectives of this course are to:

1. To understand biomolecules, microorganisms and their effect on ecosystem.
2. To be able to identify and describe the features of plant organs/tissues/cells/organelles and the relationships among major plants groups.
3. To get acquainted with various natural and genetically engineered microbes in water and solid waste treatment.

10. Course Outcomes (COs):

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

1. To understand natural degradation of pollutants with the help of microbes and fungi.
2. To understand the phenomena of nitrogen fixing.
3. To apply the uses of enzymes in different production processes.
4. To know bio-remediation of contaminants.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction of Bio-molecules**

Introduction to bio-molecules: with special reference to proteins-biologically important proteins, Nucleic acids–DNA, RNA. Biological functions of proteins, biological functions of nucleic acids. Biochemical degradation of pollutants, bio-conversion of pollutants.

Unit – 2	**Number of lectures = 15**	**Food microbiology**

Introduction to food microbiology- microbes in food production, food spoilage, food poisoning and its prevention, Classification, characteristics, occurrence and ecological significance of microorganisms, photo-autotrophs, chemo-lithotrophs, organo-trophs, parasites and their environmental significance. Soil microorganisms and their interactions relative to soil fertility, microbial toxins.

Unit – 3	**Number of lectures = 15**	**Environmental biotechnology**

Environmental biotechnology: introduction, genetic engineering and its applications, micro flora of atmosphere -sampling techniques. Identification of aero-allergens, airborne diseases and allergies, microbes and pollution abatement, Tissue culture, Fermentation, Enzyme technology. Enzyme catalysis, Michaelis-Menten equation.

Unit – 4	**Number of lectures = 15**	**Microbiology**

Applications of natural and genetically engineered micro-organisms from extreme environment: like thermophiles, alkalophiles, acidophiles and halophiles in waste treatment of different industries. Production of enzymes like cellulase, proteases amylases; alcohol and acetic acid production. Petroleum pollutant biodegradation.

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12. Brief Description of self learning / E-learning component
1. https://youtu.be/ZY8jz1dkFg8 2. https://aggie-horticulture.tamu.edu/food-technology/food-processing-entrepreneurs/microbiology-of-food/
13. Books Recommended
1. 29th edition Harper,s illustrated Biochemistry Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA McGraw Hill Publication 2. Basic ecology - E. P. Odum 3. Ecology and field biology - R.L. Smith 4. Ecology - P.D. Sharma 5. Fundamentals of ecology -E.P. Odum 6. Principles of ecology – Rickleff

Removed

1. Name of the Department : Environmental Science						
2. Course Name	Stress Physiology		**L**	**T**		**P**
3. Course Code	17090202		4	0		0
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 = 60		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Stress physiology is based on the concept of Responses of plants and animals in stress and strain related to high and low temperature conditions and high altitude.

9. Course Objectives:

The objectives of this course are to:

1. To explain the physiological adaptations evolved in animals and plants in a wide variety of environments.
2. To understand regulation of growth and development in plants and animals.
3. To understand different ecological systems in various stress conditions.

10. Course Outcomes (COs):

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

1. To apply the concept of stress and strain in plant and animals
2. Acquaint with the response of plants to different air pollutants.
3. Understand about physical and physiological adjustments in animal and plants.
4. To understand different ecological systems in various stress conditions

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction of stress physiology**

Concept of stress and strain, Environment as a source of stress in plants, Plant cell as a sensor of environmental changes, Stress factors: biotic and abiotic stress factors, methods of measurement, Water stress responses and adaptations to drought and flooding, High temperature and low temperature stress,

Unit – 2	**Number of lectures = 15**	**Ionic stress**

Responses of haloplytes and non-haloplytes to salt stress, metal toxicity and metal tolerance, Plant responses to air pollutions SO_x, NO_x, ozone, Ionic regulation and osmo-regulation, salt tolerance

Unit – 3	**Number of lectures = 15**	**Environmental Stress**

Plant responses to enriched CO2, environment, modelling photosynthetic responses to environment, Ecological significance of different CO2 fixation pathways, Circadian rhythms and biological clock.

Unit – 4	**Number of lectures = 15**	**Water stress**

Water conservation in desert animals; hibernation and aestivation, Osmo-regulation in fish, animal responses to high altitude and deep sea environment, Plant responses to UV radiations Desiccation tolerance.

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

1-https://nptel.ac.in/courses/102103015/21
2- https://nptel.ac.in/courses/102104057/7
3- https://nptel.ac.in/courses/102103012/26

13. Books Recommended

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1. Physiological Plant Ecology- Encyclopaedia (Vol. I-IV) Springer Verlag
2. Plant Physiology- Salisbury & Ross
3. Plant Ecophysiology – Prasad
4. Adaptive Animal Physiology – Nelson Schmidt.
5. Stress Physiology: D.P Singh
6. The Physiology of Plants under Stress: Erik T. Nilsen (Author), David M. Orcutt (Author)

1. Name of the Department : Environmental Science						
2. Course Name	**Atmospheric Chemistry and Pollution**	**L**	**T**	**P**		
3. Course Code	17090203	4	0	0		
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 = 60		**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.

10. Course Outcomes (COs):

Upon successful completion of this course,

1. The student will be able to apply the concepts and unifying features of atmospheric chemistry.
2. The student will be able to understand the interconnections between different layers of atmosphere.
3. The student will be able to understand the effect of human activities on the natural atmospheric constitution.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Atmospheric chemistry**

Chemical equilibria, Solubility product, unsaturated and saturated hydrocarbons, Radio nuclides. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Laws of thermodynamics, enthalpy, Carnot's cycle, entropy, Adiabatic transformations.

Unit – 2	**Number of lectures = 15**	**Dispersion of pollutants**

Atmosphere: Chemical composition of atmosphere, 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, Wind rose

Unit – 3	**Number of lectures = 15**	**Air pollution control methods**

Photo-chemical reactions in troposphere, Long Range transport of air pollutants, 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 = 15**	**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

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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- Bell & Bell
2. Introduction to Environmental Engineering & Science- Gilbert Masters
3. Geo-environment- An Introduction – V. Aswathanarayan
4. Soil Chemistry- Bolt & Buggenwert.

1. Name of the Department : Environmental Science						
2. Course Name	**Environmental Geology**		**L**	**T**		**P**
3. Course Code	17090204		4	0		0
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 = 60		**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.

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.

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.

11. Unit wise detailed content

Unit-1	**Number of lectures= 15**	**Basics of geology**

Geology as a discipline, Planet Earth. differentiation of the earth into core, mantle, crust, Special problems of time and scale in geology, Complexity in natural systems, Geology and the Scientific method. Key concepts in the history of geology. Concept of Geologic Time-Relative dating, absolute dating, the Geological time scale, Basic concepts of plate tectonics- evidences for continental drift, type of plate boundaries, plate tectonics and rock cycle, Physical properties of rocks.

Unit– 2	**Number of lectures= 15**	**Classification of minerals**

Minerals: Major rock, ore and soil forming minerals, Concept of major, trace and rare earth elements (REE) elements. Bio-geochemical cycles (N, C, S and P). Classification of trace elements, trace elements and health. Possible impacts of imbalance of some trace elements.

Unit– 3	**Number of lectures= 15**	**Oceanography and minerals**

Resources and reserves, minerals and population. Igneous, sedimentary, metamorphic, biological processes associated with formation of mineral deposits, movements of ocean water, waves and tides, types of tides, ocean currents, major ocean currents, seal evel changes and its impact on coastal areas, oceans as new areas for exploration of mineral resources, natural recycling of resources.

Unit– 4	**Number of lectures= 15**	**Geological hazards**

Geobiology/geomicrobiology and its applications, composition of the early earth atmosphere and evolution of present day atmosphere, life before oxygen, concept of biomineralization, characteristics of biominerals, biologically induced and biologically controlled biomineralisation processes. Geologic Hazards: Landslides, Earthquake, volcanoes Process of detecting, locating and measuring of geological hazards. Major types of Volcanoes and their environmental impacts.

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

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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

13. Books Recommended

1. Kurt Konhauser: Introduction to Geomicrobiology
2. Alan P. Trujillo, Harold V. Thurman - Essentials of Oceanography

1. Name of the Department : Environmental Science						
2. Course Name	**Biodiversity Conservation**		**L**	**T**		**P**
3. Course Code	17090205		4	0		0
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 = 60	**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 = 15**	**Introduction of biodiversity**

Biodiversity: Richness and evenness, Historical and geographical pattern of biodiversity; Types of biodiversity, species extinction, values and significance of biodiversity. Threats to biodiversity, levels and gradients of biodiversity. Evolution and latest theories of evolution.

Unit – 2	**Number of lectures = 15**	**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 = 15**	**Biodiversity conservation-I**

Hot spots and cold spots of Biodiversity, strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool. Ecologically relevant parameters in conservation (viable population, minimum dynamic area, effective population size) reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression), common flora and fauna of India

Unit – 4	**Number of lectures = 15**	**NGOs and biodiversity conservation-II**

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.

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.Global Biodiversity - W.R. L.IUCN
2. Ecology of natural resource - Ramade
3. Ecology - P.D. Sharma

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1. Name of the Department : Environmental Science						
2. Course Name	**Occupational Health & Safety**	**L**	**T**	**P**		
3. Course Code	17090206	2	0	0		
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 = 30	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

The course includes knowledge about Occupational Health, Industrial and Environmental Safety, Occupational diseases and their effects; Principle practices for Occupational Health and Environmental Safety Management.
It also includes basic human physiology and pathology in relation to work, working environment, stress factor, fatigue-meaning and causes of fatigue. Elements of working conditions i.e. noise, ventilation, lighting, temperature, humidity etc.
The course also includes prevention and control of occupational diseases- environmental, personal and medical control, responsibilities of safety department.

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 about necessity of industrial safety.
5. To know the impacts of occupational environment and stress on the human body and psychology.

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. To understand about Industrial and Environmental Safety measures to be taken to reduce health effects.
4. To learn the basics of occupational health issues and methods to reduce the health issues.
5. Student will able to know the responsibilities of safety officers and head of department for person working in the premises of department.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction to occupational health and safety**

Introduction, Definition of Occupational Health, Industrial and Environmental Safety, Occupational diseases and their effects. Principle practices for Occupational Health and Environmental Safety Management. Need and importance of Industrial and Environmental Safety.

Unit – 2	**Number of lectures = 15**	**Work environment and stress**

Basic human Physiology and Pathology in relation to work, Work environment, Stress factor, Fatigue-meaning and causes of fatigue, Remedies of fatigue, Elements of working conditions i.e. noise, ventilation, lighting, temperature, humidity etc. Physical and mental work; light and heavy work-monotonous and non-monotonous work.

Unit – 3	**Number of lectures = 15**	**Control measures for occupational diseases**

Prevention and control of occupational diseases- environmental, personal and medical control, Responsibilities of Safety department. Responsibilities of Medical department, Maintenance department, Purchasing department. Responsibilities of plant managers, supervisors.

Unit – 4	**Number of lectures = 15**	**Rule and regulations for occupational safety**

Safety and Health provisions of the Factories Act 1948, Occupational Safety & Health Act (OSHA), 1970. Workmen's Compensation Act, 1923. Provisions of work injuries, Benefits in the Employee's State Insurance Act,

Act, 1948.
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/
13. Books Recommended
1. Environmental Hazards and Human Health – R.B. Phillip 2. Toxicology– Principles and Applications- Niesink, John de Vries & Holligner 3. Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982 4. Occupational Health Hazards and Remedies. (2002). Mohapatra, R.Jaypee Brothers Medical Publishers Pvt. Ltd. India.

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1. Name of the Department: Environmental Sciences						
2. Course Name	Microbial Biotechnology - Lab		**L**	**T**	**P**	
3. Course Code	17090207		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 = 60**			

8. Course Description:

Environmental Biology is based on the interaction of Proteins, Nucleic acids and amino acids at molecular level in microorganisms and their fate in environment degradation.

9. Course Objectives:

1. To provide information about different elements in Earth's crust in relation to their availability, essentiality and toxicity.
2. To impart knowledge related to earth structure and constituents.

10. Course Outcomes (COs):

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

1. To understand natural degradation of pollutants with the help of microbes and fungi.
2. To know bio-remediation of contaminants.

11. List of Case Studies / Experiments

1. Demonstration of Gel Electrophoresis
2. Autoclaving of microbial culture/media
3. Demonstration of Fermentation process in Laboratory
4. DNA isolation
5. Demonstrate anaerobic respiration.
6. Microbial culture in laboratory

12. Books Recommended

1. 29th edition Harper,s illustrated Biochemistry Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA McGraw Hill Publication
2. Basic ecology - E. P. Odum
3. Ecology and field biology - R.L. Smith
4. Ecology - P.D. Sharma
5. Fundamentals of ecology -E.P. Odum
6. Principles of ecology – Rickleff

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1. Name of the Department: Environmental Science						
2.Course Name	Stress Physiology- Lab		**L**	**T**	**P**	
3.Course Code	17090208		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 = 60**			

8.Course Description:

This Course will introduce the students to understand the effects and adaptation evolved on plant species in various stress conditions. To know about the importance of different plant species in removal of different pollutants from waste water and soil.

9.Course Objectives:

The objectives of this course are to:

1. To know about the molecular content of the plants
2. To know about water movement through the plant cells.
3. To know about the impacts of air pollution on the plants
4. To make student understand impacts of different stress mechanisms.

10.Course Outcomes (COs):

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

1: Students will be able to analyze various parameters like: proline and chlorophyll content.

2: Students will gets acquainted with use of air pollution tolerance index for selection of trees for different regions.

3: Students will be able to understand and demonstrate the bioremediation and phytoremediation techniques.

11.List of Experiments

1. Estimation of proline content in plants.
2. To demonstrate the phenomena of osmosis through got bladder/parchment paper.
3. Evaluation of air pollution tolerance index (APTI) of plants.
4. Evaluation of anticipated performance index (API) of plants.
5. Estimation of sucrose content in plant sample.
6. Study of aquatic plant's Aerenchyma.

12.Books Recommended

1. Physiological Plant Ecology- Encyclopaedia (Vol. I-IV) Springer Verlag
2. Plant Physiology- Salisbury & Ross

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1. Name of the Department: Environmental Science						
2.Course Name	Atmospheric Chemistry and Pollution- Lab		**L**	**T**	**P**	
3.Course Code	17090209		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, Practicals.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 60**			

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 to:

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. Stack monitoring and analysis of different pollutants.
5. Determination of O_3 concentration in ambient air quality.
6. Study of ambient noise level.

12.Books Recommended

1. Air pollution by Rao & Rao
2. National Ambient Air Quality Series: Central Pollution Control Board

1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Geology- Practical and research work		**L**	**T**	**P**	
3. Course Code	17090210		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 = 60**			

8. Course Description:

Environmental geology Lab is helpful for understanding the different elements in Earth's crust in relation to their availability, essentiality and toxicity. This course will enhance basic skills in geology.

9. Course Objectives:

1. To provide information about different elements in Earth's crust in relation to their availability, essentiality and toxicity.
2. To impart knowledge related to earth structure and constituents.

10. Course Outcomes (COs):

Upon successful completion of this course

1. The student will have detail understanding about fundamental concepts in geology.
2. The student will be able to understand Earth's crust in relation to their availability of various earth resources.

11. List of Case Studies / Experiments

1. Identification of different types of rocks.
2. A Case Study of Bijolia Mining Area in Rajasthan, India
3. Reading a geological map and the symbols used.
4. Study of physical properties and identification of Mica & Clay minerals.
5. Every student should attend field work for a short duration and submit field diary, geological specimen and a report.

12. Books Recommended

1. Ravindrakumar: Fundamentals of Historical Geology and Sratigraphy of India.
2. Krishnan: Geology of India and Burma
3. Wadia: Geology of India.
4. Deshpande G.G.: Geology of Maharashtra

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1. Name of the Department: Environmental Sciences							
2. Course Name	Biodiversity Conservation- Practical and research work		**L**		**T**		**P**
3. Course Code	17090211		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 = 60**				

8. Course Description:

This Lab work will cover detail understanding of biodiversity pattern and there geographical distribution patterns especially in Indian scenario.

9. Course Objectives:

1. To understand biodiversity pattern and value of biodiversity
2. To know the common flora and fauna of different regions of India.

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 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 four)
2. BanwariSewa Ashram Vs State of U.P. AIR, 1987, SC 374
3. Wildlife census method (Waterhole survey, point count and line transect method, pug marks count method, King's census method)
4. To study the biodiversity present on campus.
5. Habitat and Breeding biology of a mammal and a bird.
6. Biodiversity Photography: Field work

12. Books Recommended

1. Ravindrakumar: 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

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1. Name of the Department : Environmental Science							
2. Course Name	Environmental Modeling, Computer and Statistics		**L**		**T**		**P**
3. Course Code	17090301		4		0		0
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 = 60		**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 to:

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 to

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.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction of environmental modeling**

Introduction to sampling methodology, measures of central tendency and graphical representation of data, Role of modeling in environmental science, Model classification: deterministic models, stochastic models, steady state models, dynamic models. Response Surface Methodology.

Unit – 2	**Number of lectures = 15**	**Types of environmental modeling**

Different stages involved in model building. Simple microbial growth kinetics, Monod equation. Methods for formulation of dynamic balance equations, mass balance procedures.

Unit – 3	**Number of lectures = 15**	**Models and techniques**

MS-Office (MS-Word, MS-Excel, MS-Power Point), GIS, Remote sensing, Global Positioning System: working and use, Box-Plot, Gaussian Plume Model, ERICA

Unit – 4	**Number of lectures = 15**	**Statistical packages**

Use of CSE (Computer Science and Engineering) in environmental analysis, use of statistical packages including SPSS (Statistical Product and Service Solutions) and Origin.

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

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3. https://www.powershow.com/view/1 1ff44 ZDk4Y/Environmental_Modeling_Environmental_Modeling_and_Models_powerpoint_ppt_presentation
13. Books Recommended
1. Dynamics of Environmental Bioprocesses-Modelling and simulation - Snape and Dunn. 2. Environmental Modelling – Jorgensen, S. E.

1. Name of the Department : Environmental Science							
2. Course Name	**Soil chemistry and Solid Waste Management**		**L**	**T**		**P**	
3. Course Code	17090302		4	0		0	
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 = 60		**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 landfilling, 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 Vermicomposting.
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 to

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 = 15**	**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 = 15**	**Solid waste**
Sources, generation, classification & composition of solid wastes. Solid Waste Management-Sanitary landfilling, Recycling, Composting, Vermi-composting, Incineration, Pyrolysis, energy recovery from organic waste, Waste minimization technologies,		
Unit – 3	**Number of lectures = 15**	**Hazardous waste**
Hazardous Waste Management, Sources & Classification, physico-chemical properties, Hazardous Waste		

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Control & Treatment, Hospital Waste Management, Hazardous Waste Management &Handling rules, 1989 &2000 (amendments), Fly-ash generation &utilization.		
Unit – 4	**Number of lectures = 15**	**Soil pollution**
Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants, detrimental effects of soil pollutants, remedial measures for soil pollution, soil sediments as pollutant, chemical methods of soil analysis-sample preparation and soil analysis, radioactive pollution.		
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. Solid Waste Management CPCB. New Delhi. 2. Eco-technology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr. 3. Basic Environmental Technology - J. A. Nathanson 4. Fundamentals of soil science - Henry D. Futh 5. The Nature and Properties of Soils, Brady, N. C. and Weil, R.R. Prentice-Hall, 14th Edition. Upper Saddle River, NJ, USA, 2007.		

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1. Name of the Department : Environmental Science						
2. Course Name	Social Issues & Environment		**L**	**T**		**P**
3. Course Code	17090303		4	0		0
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 = 60	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

The course includes knowledge about Sources of different pollutions: Air, Water, Soil, Noise, Radiation,
It also includes Energy use and conservation: in process heating (including heating for fluids, calcining, drying, heat treating, metal heating, melting, melting agglomeration, curing and forming) and process cooling (in refrigeration and cooling).
The course also includes Water Use and Conservation, Land contamination, Hazardous Wastes; and Human resources policy, Working conditions and terms of employment, Child labor and forced labor, Addictions: Alcohol, Tobacco, Narcotics etc.

9. Course Objectives:

The objectives of this course are:

1. To know the point and non point sources of different pollutions in environment.
2. To know about the harmful effects of excessive use of fertilizers, pesticides and toxins.
3. To know about water conservation methods in domestic, agriculture and industries.
4. To know the properties of hazardous waste and their management.
5. To know the role of consumerism and advertisement in degradation of environment.

10. Course Outcomes (COs):

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

1. To learn about the harmful effects of excessive use of fertilizers, pesticides and other toxins.
2. To understand about water conservation methods in domestic, agriculture and industries.
3. To understand the properties of hazardous waste and its management.
4. To know about the relocation policies of indigenous people by govt. and their right how to protect our cultural heritage.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Environmental pollution case studies**

Environmental pollution, Case studies: Fe-Al use, Use of cleaners in domestic sector and their harms. Overuse of fertilizers and pesticides in agriculture, Silent Spring, Lack of urban planning in pollution, Common toxins introduced in environment such as Pb, Hg, VOCs etc.

Unit – 2	**Number of lectures = 15**	**Water and energy conservation**

Energy use and conservation: in process heating (including heating for fluids, calcining, drying, heat treating, metal heating, melting, melting agglomeration, curing and forming) and process cooling (in refrigeration and cooling). Water Use and Conservation: In industries, agriculture and domestic sector; Wastewater disposal standards and cautions for different sectors.

Unit – 3	**Number of lectures = 15**	**Social issues**

Land contamination, Hazardous Wastes and Non-hazardous substitutes, Secondary containment, Hazardous waste prevention and control planning. Human resources policy, Working conditions and terms of employment, Child labor and forced labor, Addictions: Alcohol, Tobacco, Narcotics etc.

Unit – 4	**Number of lectures = 15**	**Resettlement and rehabilitation**

Consumerism and advertising in environmental degradation. Land Acquisition and Resettlement, Compensation and benefits for displaced persons, Social impact assessment, resettlement planning and implementation. Government-managed resettlement, Indigenous People, their relocation and their rights, Impacts on traditional or

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customary lands, Cultural Heritage and its protection.
12. Brief Description of self learning / E-learning component
1. http://www.conservationindia.org/topics/human-resettlement 2. https://www.tandfonline.com/doi/pdf/10.1080/07349165.1990.9726051 3. https://www.toppr.com/bytes/environmental-pollution/ 4. http://seafoodhaccp.cornell.edu/Intro/blue_pdf/Chap02Blue.pdf
13. Books Recommended
1. Environmental Chemistry by A K De by NEW AGE Publishers 2. Energy Conservation Guidebook by Dale R. Patrick, Stephen W. Fardo, Ray E. Richardson, Brian W. Fardo. CRC Press 3. Elixir: A History of Water and Humankind by Brian Fagan, Bloomsbury Press 4. Hazardous Waste Management by Michael D. Lagrega, Waveland Pr Inc 5. This Sacred Earth: Religion, Nature and Environment by Roger S Gottlie b, Psychology Press 6. Worldviews, Religion, and the Environment: A Global Anthology by Richard C. Foltz., Wadsworth Publishing. 7. Environment and Politics (Routledge Introductions to Environment: Environment and Society Texts) 4th Edition by Timothy Doyle, Routledge Publishers

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1. Name of the Department : Environmental Science						
2. Course Name	Agriculture and Environment	**L**	**T**	**P**		
3. Course Code	17090304	4	0	0		
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 = 60	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

The course includes knowledge about agricultural practices: sustainable agriculture, organic farming, dry-land farming, zero tillage, agro-forestry, social forestry irrigation practices, water logging and secondary salinization, environmental impacts of irrigation projects. It also includes production enhancing techniques and crop protection techniques; and relation of edaphic and climatic factors with crop production.

9. Course Objectives:

The objectives of this course are:

1. To know the agriculture with less water, fertilizers and pesticides.
2. To know the use of different agricultural practices to reduce land degradation.
3. To provide different methods for natural pest control and management without using toxic chemicals.
4. To learn that how to increase the crop production with less use of fertilizers and chemicals or without degrading the quality of soil. Use of manures and their relation with crop production.
5. To know the use of earthworms in composting and natural inhibitors of plant growth

10. Course Outcomes (COs):

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

1. To develop critical thinking and skills to solve contemporary problems related to environment and agriculture.
2. To address issues of the competing needs of diverse clientele and communities relating to crop and livestock production, and environmental management.
3. To identify research interest in problems related to environment and agriculture.
4. To understand the agricultural system and environmental problems posed by intensive agriculture.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Introduction of agricultu ral practices**

Agricultural Practices Sustainable agriculture, organic farming, dry-land farming, zero tillage, agro-forestry social forestry irrigation practices, water logging and secondary salinization, environmental impacts of irrigation projects.

Unit– 2	**Number of lectures= 15**	**Pest control a nd management**

Crop Protection, Chemical control Pesticides Classification, fate of insecticides and herbicides in plants, soil and factors affecting them, pesticide resistance and their remedial measures, biological & ecological pest control, Integrated Pestmanagement, Pesticidesafety .

Unit– 3	**Number of lectures= 15**	**Crop production**

Crop Production: Bi o-fertilizers, mycorrhiza, vermi-composting, allelopathy Biotechnological innovations in crop protection Water-use efficiency in relation to crop production, Essential plant nutrients and other beneficial elements in soils and plants Impact of high-yielding and short-duration varieties, impact of genetically modifiedcrops: case studies.

Unit – 4	**Number of lectures = 15**	**Weather andcrop production**

Weather & crop productivity: Impact of glo bal warming on agriculture and food security; Green- Revolution-

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environmental implications, NPK fertilizers and their environmental effects. Correlation of crop growth with environmental parameters like temperature, sunshine, relative humidity.
12. Brief Description of self learning / E-learning component
1. https://en.wikipedia.org/wiki/Sustainable_agriculture 2. https://asi.ucdavis.edu/programs/ucsarep/about/what-is-sustainable-agriculture 3. https://www.nal.usda.gov/afsic/sustainable-agriculture-definitions-and-terms
13. Books Recommended
1. Sustainable Agriculture – H.R. Sharma 2. Global Climate Change – Pary Martin 3. Allelopathy – S.S. Narwal 4. Environmental Chemistry – Stanley E. Manahan 5. Soils – Miller and Donhau 6. Environment and Agriculture – Dhaliwal, Jairath and Hans

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1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Modeling, Computer and Statistics-Lab	**L**	**T**	**P**		
3. Course Code	17090305	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 = 60**				

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 to:

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 sciences.
5. To learn about different stages involved in model building.

10. Course Outcomes (COs):

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

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.

11. List of Case Studies / Experiments

1. Application Basic Microsoft Office Software
2. Graphical representation of data
3. Use of statistical packages including SPSS (Statistical Product and Service Solutions)
4. Application and use ERICA
5. Environmental Modeling softwares and their applications.

12. Books Recommended

1. Dynamics of Environmental Bioprocesses-Modelling and simulation - Snape and Dunn.
2. Environmental Modelling – Jorgensen, S. E.

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1. Name of the Department: Environmental Science						
2.Course Name	Soil Chemistry and Solid Waste Management-Lab		**L**	**T**	**P**	
3.Course Code	17090306		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, Practicals.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 60**			

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 to:

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.
6. To determine Nitrogen and Phosphorus concentration from soil samples.

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 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, R.R. Prentice-Hall, 14th Edition. Upper Saddle River, NJ, USA, 2007.
2. Solid Waste Management CPCB. New Delhi.

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1. Name of the Department: Environmental Sciences							
2. Course Name	Social Issues and Environment-Practical and research work		**L**	**T**		**P**	
3. Course Code	17090307		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 = 60**				

8. Course Description:

The course also includes Water Use and Conservation, Land contamination, Hazardous Wastes; and Human resources policy, Working conditions and terms of employment, Child labor and forced labor, Addictions: Alcohol, Tobacco, Narcotics etc.

9. Course Objectives:

The objectives of this course are:

1. To know the point and non point sources of different pollutions in environment.
2. To know about the harmful effects of excessive use of fertilizers, pesticides and toxins.
3. To know about the energy conservation methods used in industries.
4. To know about water conservation methods in domestic, agriculture and industries.

10. Course Outcomes (COs):

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

1. To learn about the harmful effects of excessive use of fertilizers, pesticides and other toxins.
2. To understand about water conservation methods in domestic, agriculture and industries.

11. List of Case Studies /Experiments

1. Survey work on minimum two local environmental problems / environment awareness.
2. Epidemiological survey in any local area for Fluoride.
3. Report on Tehri Dam Conflict: Case study
4. 'Old' and 'New' Social Movements in India
5. Report on Famous Environmentalists of India.
6. Field work report on Any village / City/ Town depicting status of environmental Condition.

12. Books Recommended

1. Environmental Chemistry by A K De by NEW AGE Publishers
2. Energy Conservation Guidebook by Dale R. Patrick, Stephen W. Fardo, Ray E. Richardson, Brian W. Fardo. CRC Press
3. Elixir: A H story of Water and Humankind by Brian Fagan, Bloomsbury Press
4. Hazardous Waste Management by Michael D. Lagrega, Waveland PrInc
5. This Sacred Earth: Religion, Nature and Environment by Roger S Gottlieb, Psychology Press

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1. Name of the Department: Environmental Science						
2.Course Name	Agriculture and Environment-Practical and research work		**L**	**T**	**P**	
3.Course Code	17090308		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, Practicals.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 60**			

8.Course Description:

This Course will introduce the students to understand the agricultural system and environmental problems posed by intensive agriculture. To learn about the different types of pesticides and their classification on the basis of chemical composition. To be able to analyze the basic physico-chemical properties of soil.

9.Course Objectives:

The objectives of this course are to:

1. To know the methodology for pesticide estimation.
2. To know the effect of different pollutants on plant growth.
3. To know the difference in soil quality of different fields.
4. To know the ionic exchange in the soil.

10.Course Outcomes (COs):

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

1: Students will be able to determine the concentration and type of pesticides in soil, water and environment.

2: Students will also be able to explain the relation between soil parameters like cation exchange capacity and electrical conductivity.

3: Students will also able to understand and use different methods and techniques for analysis of Na and K concentration in soil.

11.List of Experiments

1. Estimation of Ammonical nitrogen and nitrate concentration in soil and plant samples.
2. To study the effects of effluent on plant growth.
3. To assess the variation in soil pH and Electrical conductivity in soils from different fields.
4. Determination of the cation exchange capacity of soil from different fields.
5. Study of allelopathic effect within plant systems.
6. Study of organic carbon from soil samples.

12.Books Recommended

1. Sustainable Agriculture – H.R. Sharma
2. Environment and Agriculture – Dhaliwal, Jairath and Hans

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1. Name of the Department : Environmental Science						
2. Course Name	Environmental Impact Assessment and Risk Analysis	**L**	**T**	**P**		
3. Course Code	17090401	4	0	0		
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 = 60		**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 environmental 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 = 15**	**Introduction to EIA**

EIA: Environmental impact assessment: Introduction, aims, objectives, constraints in EIA, goals, principles and significance; Regulatory bodies, Concept of rapid and comprehensive EIA, Cumulative EIA, Strategic Environmental Assessment (SEA)–Principles and process; EIA notification (MOEF)1994, 2006; Steps of EIA; Screening and scoping; Acquisition of baseline data, its importance.

Unit – 2	**Number of lectures = 15**	**Methods of Impacts Identification and Mitigation**

Impacts Identification methods (check lists, overlays, Matrices, Models, Comparative studies), Impact prediction, models of prediction, Impact evaluation–Cost benefit analysis, methods of monetary evaluation of environmental parameters, multi-criteria approach, mitigation of impacts– approaches and methods in relation to different development projects.

Unit – 3	**Number of lectures = 15**	**Environmental Management System**

Public participation in EIA, presentation and review process, methods and role of monitoring in EIA, 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 = 15**	**EIA-Guidelines and Case studies**
Environmental Impacts of mining industry, nuclear and thermal power plant, textile industry, paper and pulp 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 byAnji Reddy Mareddy, Anil Shah, Naresh.
2. Environmental Impact Assessment – John Glasson
3. Methods of Environmental Impact Assessment – Morris &Therivel
4. Environmental Impact Assessment – L.W. Canter
5. Chemical Principles of Environmental Pollution – Alloway& Ayers
6. Industrial Environment – Assessment and Strategy – S.K. Aggarwal
7. Handbook of Environmental Assessment, (Vol.-I & II) – Judith Petts

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1. Name of the Department : Environmental Science						
2. Course Name	Environmental Toxicology and Health	**L**	**T**	**P**		
3. Course Code	17090402	4	0	0		
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 = 60		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

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 to:

1. Describe the health hazards associated with different occupations and the causes behind them.
2. Know about the role of biogeochemical factors in transfer and exposure of toxicants.
3. Identify the different toxic chemicals on the basis of their chemical nature.
4. Know about different heavy metals and health effects of their high concentration.
5. Explain various sources of pesticide pollution in water and their health effects.

10. Course Outcomes (COs):

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

1. Understand the carcinogenic effect of different pollutants.
2. Know about natural and anthropogenic radioactivity, radiation dosimetry and effect of radiation on the plant and animal body.
3. Understand toxicity mechanism of some common pesticides and their derivatives.
4. Explain the bio-transformation and detoxification mechanisms.
5. Know about the harmful chemicals and substances present in water.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Occupational Health Hazards**

Toxicology: Introduction, basic concepts of toxicology, toxicant hazards (Lead, Mercury, Cadmium, Arsenic, Cobalt, Iron and pesticides), Occupational health hazards, epidemiological issues-goiter, fluorosis, arsenic poisoning.

Unit – 2	**Number of lectures = 15**	**Toxicants in Environment**

Toxic chemicals in the environment, pesticides in water and soil, bio-chemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Unit – 3	**Number of lectures = 15**	**Toxicants Route of Entry and Exposure**

Mode of entry of toxic substance, Xenobiotics (Absorption, Transport and Execution of chemicals), Biomagnification, Bio-monitoring of toxic chemicals, carcinogens in air water and soil, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing.

Unit – 4	**Number of lectures = 15**	**Health Effects of Toxic Chemicals**

Insecticides, pesticide dose, effect and toxicity relationship, environmental radioactivity,reference dose, Lethal dose: LD-50, LD-10; dose response, role of geometry in radiation dose, radiation

dosimetry.
12. Brief Description of self learning / E-learning component
1. https://www.britannica.com/science/environmental-toxicology 2. https://www.slideshare.net/gauravhtandon1/environmental-toxicology-32480341
13. Books Recommended
1. Fundamental concepts of Environmental chemistry_ G S Sodhi 2. Principals of Environmental Chemistry_ Manahan 3. Environmental hazards & human health R.B. Philip 4. Toxicology_ principles & applications - Niesink& Jon devries 5. Parasitology - Chatterjee 6. Preventive & Social medicines – Perk

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1. Name of the Department : Environmental Science						
2. Course Name	Environmental Economics		**L**	**T**	**P**	
3. Course Code	17090403		4	0	0	
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 = 60		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

Environmental economics familiarize students with the application of economics to environmental problems and prepare them for analyzing issues in environmental development and policy for environmental protection. This course explains the relationship between environmental degradation and economical development. This course also focuses on preparation of environmental friendly policies and methods.

9. Course Objectives:

The objectives of this course are to:

1. Aware students about the development policy.
2. Describe about the relationship between economic growth and environmental growth.
3. Explain ecosystem stability with material balance approach.
4. Explain convention, treaties and protocols for environmental audit and protection of natural resources.
5. Describe theories to manage natural resources and analysis of statistics on the economy.

10. Course Outcomes (COs):

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

1. Understand relationship between economic growth and environmental growth.
2. Understand the role of policies in development and environmental protection.
3. Know about the role of forest resources in economics.
4. Use analytical techniques for analysis of statistics on the economy.
5. Understand concepts of sustainable development and its role in economics.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Ecology, Environment and Economics**

Environment and Ecosystems; Material Balance Approach; Principles of Uncertainty, Irreversibility, Inter-Temporal Efficiency, Inter-Generational Equity; Environment-Development Trade-Offs; Environmental Costs of Economic Growth, Limits to Growth; Sustainable Development — Concepts and Indicators; Environmental Kuznets' Curve

Unit – 2	**Number of lectures = 15**	**Natural Resource and Economy**

Environmental Statement (ES), ES of Govt. of India and its contents, Introduction to Environmental audit, Guidelines and methodology. Natural resource accounting for Indian condition; Economic development and environmental impact, Irrigation projects and Environmental costing:, Economic value of India's forest stock and economics of forest products in India.Carbon Credit & Carbon Trading, Ecological Foot Print, carbon sequestration.

Unit – 3	**Number of lectures = 15**	**Protocols and Treaties**

Convention on Conservation of Antarctic marine (1980) and mineral living resources, Treaty on principles governing the activities of state in the exploration and use of outer space (1967),

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International convention on the high seas fishing and living resources (1958) and intervention of oil pollution casualties (1969). United Nations Convention to Combat Desertification (1994).

Unit – 4	**Number of lectures = 15**	**Role of Natural Resources in GDP**

Economics of Resource Management; Theories of Optional Use of non-renewable and renewable Resources; Integrated Environmental and Economic Accounting and the Measurement, Environmentally Corrected GDP; Comprehensive Wealth and Genuine savings; Global Environmental Governance.

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

1. https://www.investopedia.com/terms/e/environmentaleconomics.asp
2. https://www.slideshare.net/mccracken/environmental-economics-4790490

13. Books Recommended

1. Fisher, A.C. (1981): Resource and Environmental Economics, CUP, Cambridge.
2. Hanley, Shogren and White (1997): Environmental Economics in Theory and Practice, Macmillan.
3. Pearce, D.W. and R. Turner (1991): Economics of Natural Resource Use and Environment, John Hopkins Press, Baltimore.
4. Tietenberg, T. (1994): Environmental Economics and Policy, Harper Collins, NY.

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1. Name of the Department : Environmental Science							
2. Course Name	Environmental Legislations and Awareness		**L**	**T**		**P**	
3. Course Code	17090404		4	0		0	
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 = 60		**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 NGO s 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 = 15**	**Labeling of products and Laws**

Environmental Laws: Introduction to international environmental law (Stockholm to Rio), Introduction to National laws (Constitution and other relevant statues), Scheme of Labelling of environment-friendly products (Ecomark), Public liability Insurance Act. 1991, Provision of constitution of India regarding environment (article 48 A & 51 A).

Unit – 2	**Number of lectures = 15**	**Environmental Conventions and Protocols**

Sustainable Development, The Stockholm Declaration, Earth Summit, Convention on protection of environment, Ramsar convention on wetlands, Outer space treaty, Vienna convention &Montreal Protocol, Kyoto Protocol.

Unit – 3	**Number of lectures = 15**	**Prevention and Control of Pollution Laws**

Pollution control through legislation ;with special reference to the 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 – 4	Number of lectures = 15	Environmental Awareness
Ganga Action Plan (1986 and 2014), Yamuna Action Plan, Latest Plantation and Tree migration Technologies. Role of media in environmental awareness, role of NGOs in environmental movements, Chipko movement, Appiko movement. Case studies to be taken up: M.C. Mehta vs Union of India; Ganga pollution case of Tanneries, M.C. Ganga pollution (Municipalities)		
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 2. Environmental Law Paperback –NishthaJaswal and P.S.Jaswal 3. Environmental Planning, Policies &Programmes in India – K.D. Saxena 4. Land – Use and Environment – S.M. Mujtava 5. Environmental Administration and Law- Paras Diwan.		

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1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Impact Assessment and Risk Analysis- Lab		**L**	**T**	**P**	
3. Course Code	17090405		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 = 60**			

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.

9. Course Objectives:

The objectives of this course are to:

1. Describe basic procedure and details of EIA.
2. Promote environmental 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

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.

11. List of Case Studies / Experiments

1. EIA of hydroelectric Dams: Case study
2. EIA of Thermal power plant: Case study
3. EIA of Town ship : Case study
4. EIA of highway : Case study
5. EIA of Brick Kilns : Case study
6. EIA of Delhi Metro: Case study

12. Books Recommended

1. Environmental Impact Assessment: Theory and Practice byAnji Reddy Mareddy, Anil Shah, Naresh.
2. Environmental Impact Assessment – John Glasson
3. Methods of Environmental Impact Assessment – Morris &Therivel
4. Environmental Impact Assessment – L.W. Canter
5. Chemical Principles of Environmental Pollution – Alloway& Ayers
6. Industrial Environment – Assessment and Strategy – S.K. Aggarwal
7. Handbook of Environmental Assessment, (Vol.-I & II) – Judith Petts

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1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Toxicology and Health- Lab		**L**	**T**	**P**	
3. Course Code	17090406		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 = 60**

8. Course Description:

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

9. Course Objectives:

The objectives of this course are to:

1. Describe the health hazards associated with different occupations and the causes behind them.
2. Know about the role of biogeochemical factors in transfer and exposure of toxicants.
3. Identify the different toxic chemicals on the basis of their chemical nature.

10. Course Outcomes (COs):

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

1. Understand the carcinogenic effect of different pollutants.
2. Know about natural and anthropogenic radioactivity, radiation dosimetry and effect of radiation on the plant and animal body.

11. List of Case Studies / Experiments

1. Case studies of Cancer in Punjab
2. Study of Lethal dose, LD-50, LD-10; dose response,
3. Study of Occupational health hazards from coal mining.
4. Effects of toxicants used in agriculture on human health, Survey & report.
5. Epidemiological Issues of Fluoride and Iron, Case Studies

12. Books Recommended

1. Fundamental concepts of Environmental chemistry– G S Sodhi
2. Principals of Environmental Chemistry– Manahan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications- Niesink& Jon devries
5. Parasitology - Chatterjee
6. Preventive & Social medicines – Perk

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1. Name of the Department: Environmental Sciences						
2. Course Name	Environmental Economics- Practical and research work		**L**	**T**	**P**	
3. Course Code	17090407		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 = 60**			

8. Course Description:

Environmental economics familiarize students with the application of economics to environmental problems and prepare them for analyzing issues in environmental development and policy for environmental protection.

9. Course Objectives:

The objectives of this course are to:

1. Aware students about the development policy.
2. Describe about the relationship between economic growth and environmental growth.
3. Explain ecosystem stability with material balance approach.
4. Explain convention, treaties and protocols for environmental audit and protection of natural resources.

10. Course Outcomes (COs):

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

1. Understand relationship between economic growth and environmental growth.
2. Understand the role of policies in development and environmental protection.
3. Know about the role of forest resources in economics.

11. List of Case Studies / Experiments

1. Estimation of Carbon foot print.
2. Report on carbon credit and carbon trading of any two industries.
3. Estimation of Cost Benefit analysis.
4. Life cycle estimating of any product.
5. Concept of Demand and Supply.
6. Environmental Auditing report for any firm or Industry.

12. Books Recommended

1. 1Fisher, A.C. (1981): Resource and Environmental Economics, CUP, Cambridge.
2. Hanley, Shogren and White (1997): Environmental Economics in Theory and Practice, Macmillan.
3. Pearce, D.W. and R. Turner (1991): Economics of Natural Resource Use and Environment, John Hopkins Press, Baltimore.
4. Tietenberg, T. (1994): Environmental Economics and Policy, Harper Collins, NY.

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1. Name of the Department: Environmental Sciences							
2. Course Name	Environmental Legislations and Awareness-Practical and research work		**L**	**T**	**P**		
3. Course Code	17090408		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 = 60**				

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.

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.

11. List of Case Studies / Experiments

1. Case studies to be taken up: M.C. Mehta vs Union of India
2. Case studies of Ganga Action Plan (1986and2014).
3. Case studies of Yamuna Action Plan.
4. Narmada Bachao Andolan: Case study
5. Tehri Dam: Case study

12. Books Recommended

1. Environmental Law in India- P. Leelakrishnan
2. Environmental Law Paperback –Nishtha Jaswal and P.S. Jaswal
3. Environmental Planning, Policies & Programmes in India – K.D. Saxena
4. Land – Use and Environment – S.M. Mujtava
5. Environmental Administration and Law- Paras Diwan.

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SHREE GURUGOBIND SINGH TRICENTENARY UNIVERSITY
FACULTY OF SCIENCE
DEPARTMENT OF ENVIRONMENTAL SCIENCE
Ph.D. ENVIRONMENTAL SCIENCECOURSE WORK
W.e.f the academic session Aug 2019

Techniques in Environmental Science

Time: 3 hrs.Max. Marks: 100

Formative Assessment : 20
Summative Assessment : 80

Note: Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Question number 01 will be compulsory containing 08 short answer type questions covering the entire syllabus. Further, examiner will set 02 questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

UNIT-I
ENVIRONMENTAL BIO-TECHNOLOGY

Introduction, scope and importance of biotechnology, Applications, Genetic engineering, techniques – Electrophoresis, Isolation and purification of DNA, PCR, Biosensors, Bioremediation, Fermentation.

UNIT-II
SOLID WASTE TREATMENT

Treatment processes, Aerobic and anaerobic treatment methods – Role of microbes, methanogens, acetogens, fermentative bacteria, biofilms, and Waste management: Solid waste composting and vermi-composting, Xenobiotic compounds, Biodegradation.

UNIT-III
REMOTE SENSING

Remote sensing, EMR interaction with earth surface materials, Spectral signatures of vegetation, water bodies, ground truth data collection, operational remote sensing satellites. Remote Sensing Applications.

UNIT-IV
ANALYTICAL TECHNIQUES

Spectrophotometer, Flame photometer, Atomic Absorption Spectrophotometer, High pressure Liquid Chromatography, Gas Chromatography, XRD, SEM (Scanning Electron Microscope), TEM(Transmission Electron Microscope).

Reference Books:

1. Bruce Rittman, Perry L. McCarty (2000) Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill.
2. Joseph, George. 2005. Fundamentals of Remote Sensing, 2nd Edition. University Press India.
3. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India.

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ENVIRONMENTAL HISTORY & CONTEMPORARY POLICIES

Unit- 1

Ancient History

A concise history, from ancient to modern times, of the interactions between human societies in relationship to ecosystems. Present day environmental dilemmas, conflicts and choices that have their roots in the past.

Unit-2

Environmental History-I

Introduction to the ideology of environmentalism and environmental history, Modern environmental movements. The Gaia theory.

History of the development of environmental history as a discipline and its relationship with social and economic history. Methods and Sources of Environmental History: Distributions from other types of history.

Unit-3

Environmental History-II

Environmental History as Natural History: In the developed and developing nations. Ideas of wilderness and conservation. Environmental History as a History of Industrialization and Anti-Industrialization: debates on the nature of modernization and industrialization in developed and developing countries. Issues of its links with history of science and technology.

Unit-4

Contemporary Ideas

The Rise of European power and its consequences not only for peoples, but also for plants and pathogens, animals and landscapes.

Nature and Empire: Debate on 'colonialism as a watershed'. Colonialism and the unleashing of destructive forces and the threat of general environmental decline.

Books Recommended:

1. Arnold, David &Guha, Ramachandra (Ed.), 1995, Nature, Culture, Imperialism: Essays on the Environmental History of South Asia, Oxford University Press, Delhi.
2. BaviskarAmita, 2003, 'Tribal Discourse and Indian environmentalism in Greenough, Paul and Anna.
3. LowenhapeptTsing (Ed.), Nature in the Global South: Environmental Projects in South and SouthernAsia, Durham and, London: Duke University Press/Orient Longman.
4. Balee William, 1998, Advances in Historical Ecology, Columbia University Press, New York.
5. Beinart William and Coates Peter, 1995, Environment and History, London: Routledge. Carson, Rachel, 1962, Silent spring. Houghton Miflin, Boston.

ENVIRONMENTAL TOXICITY AND HUMAN HEALTH

Unit- 1

Occupational Health Hazards

Occupational health hazards, biogeochemical factors in environmental health, epidemiological issues-goiter, fluorosis, arsenic poisoning.

Unit-2

Toxic chemicals

Toxic chemicals in the environment, pesticides in water, bio-chemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Unit-3

Biotransformation

Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing.

Unit-4

Insecticides & Dose

Insecticides, MIC effects, pesticide dose, effect and toxicity relationship, environmental radioactivity, radiation dosimetry.

Books Recommended:

1. Fundamental concepts of Environmental chemistry – G.S Sodhi
2. Principals of Environmental Chemistry – Manahan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications - Niesink& Jon devries
5. Parasitology - Chatterjee Preventive & Social medicines – Perk

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INSTRUMENTATIONS AND ANALYTICS

Unit- 1

Spectrophotometry

Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Titrimetry, Gravimetry, Colourimetry.

Unit- 2

Microscopy

NMR, ESR, Microscopy-phase, light and fluorescence microscopes, Scanning and Transmission electron microscopes.

Unit- 3

Chromatography

Chromatographic techniques (Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography), Atomic absorption spectrophotometry, Hydrodynamics methods, Plasma emission spectorocopy.

Unit- 4

Other methods use in analytical techniques

Electrophoresis, solid and liquid scintillation, X-ray florescence, X-ray diffraction. Flame photomtery, Gas-liquid chromatography, High pressure liquid chromatography – auto radiography, Ultracentrifugation.

Books Recommended:

1. Undergraduates Instrumental Analysis- James W. Robinson

2. Modern methods of Chemical analysis- Robert, Shields, Cairns, William.

3. Fundamentals of Analytical Chemistry 8th Edition- Skoog, West, Holler and Crouch, Cengage Learning India.

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