Learning Outcomes based Curriculum Framework (LOCF)

For

M. Sc. (Environmental Science)
Postgraduate Programme

Department of Energy and Environmental Sciences
Chaudhary Devi Lal University
Sirsa-125055
2021

Table of Contents

1. About the Department

The vision, mission and objectives of the department is to strive for excellence, to achieve sustainable development, to impart training for capacity building, to tackle various environmental challenges in an eco-friendly manner, to offer professional and job-oriented course curricula, to strengthen R&D activities and to offer consultancy and extension activities. The faculty members of department have exposure of reputed national and international organisations of different specialization. The faculty members are engaged in extensive research in the frontier areas of Environmental sciences. The department is providing platform in various dimensions to the students to participate in various cultural, co-curricular activities organized by the department and different cells of the university. The department effectively guides the students throughout the study period and Alumni of the department have been serving in various sectors of environmental services.

2. Learning Outcomes based Curriculum Framework

The Choice Based Credit Scheme evolved into learning outcomes-based curriculum framework and 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. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the programme

The prime objective of the programme is to reach the unreached and help to provide environmental education at the doorstep of the learners and according to their convenience. To contribute to eco-sustainability and efficient use of natural resources through integrated nexus for the long-term benefit and welfare of society through quality education, innovative research, outreach and grassroot activities and overall networking with the environment. Curriculum have been designed to attract young minds to choose a career in broad areas of Environmental Science and applications. This programme has also been envisaged to fulfil

the requirement of technical manpower in various sectors including academia-industry linkage and elsewhere.

2.2 Programme Outcomes (POs)

PO1	Knowledge: impart knowledge in the basic and advanced fields of the core and applied disciplines to enable the students to have a thorough understanding of the concerned fields for fulfilment of their professional requirements.
PO2	Critical Thinking: develop the capability of critical thinking based on the contextual knowledge of living beings/organisms, non-living components and environmental basis of life so as to enable the students to critically analyse everyday problems faced by society
PO3	Interdisciplinary Approach & Adaptation: make the students understand the vital connections, within and among-the flora, fauna and the physical environment for enhancing their ability to integrate as well as synthesize the acquired knowledge within their fields and beyond
PO4	Application Development: make the students understand and develop the applications of biological materials in food, health, medicine and environment for sustainable development of the society
PO5	Ethics and Leadership: make the students aware about sound professional and character ethics as well as to inculcate the qualities of leadership and team building skills.
PO6	Problem Solving: train the students for developing innovative and solution centered approach for handling any kind of problem and to inculcate the paradigm of scientific temperament in the students.
PO7	Skills and Inferential knowledge: inculcate various core and advanced skills and to develop theoretical and practical understanding of different descriptive and inferential statistical tools and techniques.
PO8	Specialization and Employability: impart practical training, field's visits and project based vocational training as well as specialization to the students for preparing them for an entrepreneurial thinking and career-oriented approach in research as well as in industries.

2.3Programme Specific Outcomes (PSOs)

PSO1	Course provide wide range of knowledge on various aspects of different spheres of the environment viz atmosphere, hydrosphere, lithosphere and biosphere and generate awareness on Environmental Pollution, toxicology, Climatic Change along with their inter- linkages to human health.
PSO2	Course convey education among students on Environmental Impact Assessment study of various environmental components, environmental laws, their effectivity and their long-term outcome from environmental point of view.
PSO3	Course provides knowledge on concepts, tools and modern techniques and instruments for analysis of various components of environment and their management. Also enable to tackle various environmental challenges in an eco-friendly and sustainable manner and educate students on Natural Resource Management for Sustainable Development.
PSO4	Course include training for capacity building, to offer professional and job-oriented course curricula, to strengthen R&D activities and to offer consultancy and extension activities.

3. Programme Structure

M.Sc. Environmental science is a four-semester postgraduate programme having 110 credits weightage consisting of Core Courses (CC), Discipline Specific Elective Courses (DSC), Skill enhancement courses (SEC) and Open Elective Courses (OEC).

Table 1: Course and Credit Scheme

Semester	Core Courses (CC) 1	2	Discipline Specific Elective Courses (DSC) 3	4	Skill Enhancement Courses (SEC) 5	6	Open Elective Courses (OEC) 7		Grand Total Credits
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	A total of 12 credits to be earned from other departments or from MOOCs Students have to opt open elective course in consultation with chairperson and director, university Centre for outreach Programmes and Extension		2+4+6+7
I	5	20	-	-	1	4			
II	3	12	3	12	1	4			
III	4	16	1	2	1	4			
IV	5	20	2	4	-	-			
Total	Core Credits	68	Discipline Specific Elective Credits	18	Skill Enhancement Credits	12	Open Elective Credits	12	110
%age	Core Credits	61.81	Discipline Specific Elective Credits	16.37	Skill Enhancement Credits	10.91	Open Elective Credits	10.91	100

Table 2: Detailed break-up of Credit Courses

Sem.	Core Courses	Discipline Specific Elective Courses	Skill Enhancement Courses	Open Elective Courses	Total Courses
	CC	DSC	SEC	OEC	CC+DSC+ SEC
I	CC1 CC2 CC3 CC4 CC5	--	SEC1	OECs offered by other departments or MOOCs (may be enrolled in any of the four semesters)	6
II	CC6 CC7 CC8	DSC1 DSC2 DSC3	SEC2		7
III	CC9 CC10 CC11 CC12	DSC4	SEC3		6
IV	CC13 CC14 CC15 CC16 CC17	DSC5 DSC6			7

Table 3: Course code and Title along with credits detail

Course Code	Course Title	Credits			
	Semester I	Theory	Practical	Total	
MSc/EES/1/CC1	Earth Processes and Natural disasters	4	0	4	
MSc/EES/1/CC2	Ecology	4	0	4	
MSc/EES/1/CC3	Environmental chemistry	4	0	4	
MSc/EES/1/CC4	Physical environmental	4	0	4	
MSc/EES/1/CC5	Lab I-Ecology	0	4	4	
MSc/EES/1/SEC1	Lab II-Environmental monitoring:Soil	0	4	4	
	Total	**16**	**8**	**24**	
Semester II					
MSc/EES/2/CC6	Biodiversity and Environmental issues	4	0	4	
MSc/EES/2/CC7	Environmental Pollution	4	0	4	
MSc/EES/2/CC8	Lab IV-Environmental monitoring: Air and Noise	0	4	4	
MSc/EES/2/DSC1	(A) Environmental Impact Assessment	4	0	4	
	(B) MOOCs on SWAYAM Portal				
MSc/EES/2/DSC2	(A) Analytical Techniques	4	0	4	
	(B) MOOCs on SWAYAM Portal				
MSc/EES/2/DSC3	(A) Biostatistics & Computer Application	4	0	4	
	(B) Academic integrity, Ethics& Biosafety				
	(C) MOOCs on SWAYAM Portal				
MSc/EES/2/SEC2	Lab III-Environmental monitoring: Water	0	4	4	
	Total	**20**	**8**	**28**	
Semester III					
MSc/EES/3/CC9	Environmental Microbiology	4	0	4	
MSc/EES/3/CC10	Pollution Control &Management	4	0	4	
MSc/EES/3/CC11	Environmental Biotechnology	4	0	4	
MSc/EES/3/CC12	Environmental law	4	0	4	
MSc/EES/3/DSC4	Credit Seminar	2	0	2	
MSc/EES/3/SEC3	(A)Lab V- Environmental Microbiology	0	4	4	
	(B) Lab V- Solid Waste				
	(C) Lab V- Practical aspects of Energy				
	Total	**18**	**4**	**22**	
	Semester IV				
MSc/EES/4/CC13	Energy Resources	4	0	4	
MSc/EES/4/CC14	Environmental Health and Toxicology	4	0	4	

MSc/EES/4/CC15	Remote Sensing &Modelling	4	0	4	
MSc/EES/4/CC16	Natural Resources management	4	0	4	
MSc/EES/4/CC17	Lab VI-Environmental Biochemistry	0	4	4	
MSc/EES/4/DSC5	Field visit (Industry/Institution/In situ-Ex situ conservation site/Ecosystem)	2	0	2	
MSc/EES/3/DSC6	Project/skill development/ In house training/Industrial training	2	0	2	
	Total	**20**	**4**	**24**	

Notes:

1. For one credit of theory, one hour of lecture will be delivered while for one credit of practical, two hours of laboratory work will be conducted, per week.
2. Practical will be conducted in groups; one group will have maximum of 20 students.
3. Besides credits from above courses, students will need to earn additional 12 credits from open elective courses (OECs) offered by other departments of the University or from MOOCs on SWAYAM portal. Students are free to get enrolled for this category courses in any of the semesters. Further, students may get enrolled in any of the various PG MOOCs available at SWAYAM portal for this category for the desired credits.
4. MOOC coordinator will display the list of MOOCs for each Discipline Specific Elective Course (DSC) before the commencement of respective semester.
5. A Discipline Specific Elective Course will be started only when least 10 students opt for a particular course.
6. *Students will need to submit a certificate declaring their successful completion of 'Project/skill development/ In house training/Industrial training' for the desired number of hours.
7. **Two classes per week will be held for 'Life skills and Humanistic values' course.
8. Rules pertaining to Project:
    i. Allotment of students for the Project will be done in the beginning of third semester.
    ii. The work will commence with third semester and will continue till the last day of teaching term of fourth semester (as notified in Academic Calendar).
    iii. The last day of fourth semester (as notified in Academic Calendar), will be the last date for submission of project report.
    iv. If any student fails to submit within the stipulated period, an extension of three months may be granted by the chairperson with a fine of Rs 500. Extension beyond three months may also be granted by the chairperson but only under special circumstances and with a fine of Rs 1000.
    v. Project Report will comply with the Plagiarism Policy of the University.
    vi. Three paper back copies and one soft copy (PDF format) of the Project Report will be prepared. The soft copy will be sent to the library while the paper back copies will be one each for student, supervisor and departmental record.

vii. Any patent/IPR based on the experimental work will be filed in the name of the University. The concerned student/s and guide will be the inventors.

viii A publication based on project should be with the consent of guide only.

ix. Guidance of students for the Project will contribute towards 1 credit of workload for teachers if the number of students is less than 5. In case, number of students being guided by one teacher is 5 or more, teacher will be credited with workload of 2 credits.

x. The Project Report will be compiled in the following format:

Project Report	**In house training/Industrial training Report**
Acknowledgement	Acknowledgement
Certificate of Supervisor	Certificate of the concerned authority
Plagiarism Verification report	Plagiarism Verification report
Introduction	Introduction
Review of Literature	Overview of theme and Discussion in the light of available literature
Materials and Methods	Conclusions and Findings
Results and Discussion	
Summary	
Bibliography	Bibliography

Table 4: core courses offered by the Department of Energy and Environmental Sciences

Course Code	Course Title	Credits
MSc/EES/1/CC1	Earth Processes and Natural disasters	4
MSc/EES/1/CC2	Ecology	4
MSc/EES/1/CC3	Environmental chemistry	4
MSc/EES/1/CC4	Physical environmental	4
MSc/EES/1/CC5	Lab I-Ecology	4
MSc/EES/2/CC6	Biodiversity and Environmental issues	4
MSc/EES/2/CC7	Environmental Pollution	4
MSc/EES/2/CC8	Lab IV-Environmental monitoring: Air and Noise	4
MSc/EES/3/CC9	Environmental Microbiology	4
MSc/EES/3/CC10	Pollution Control & Management	4
MSc/EES/3/CC11	Environmental Biotechnology	4
MSc/EES/3/CC12	Environmental Law	4
MSc/EES/4/CC13	Energy Resources	4
MSc/EES/4/CC14	Environmental Health and Toxicology	4
MSc/EES/4/CC15	Remote Sensing & Modelling	4
MSc/EES/4/CC16	Natural Resources Management	4
MSc/EES/4/CC17	Lab VI-Environmental Biochemistry	4
	Total	**68**

Table 5: Discipline Specific Courses offered by the Department of Energy and Environmental Sciences

MSc/EES/2/DSC1	(A) Environmental Impact Assessment	4
	(B) MOOCs on SWAYAM Portal	
MSc/EES/2/DSC2	(A) Analytical Techniques	4
	(B) MOOCs on SWAYAM Portal	
MSc/EES/2/DSC3	(A) Biostatistics & Computer	4
	(B) Academic integrity, Ethics& Biosafety	
	(C) MOOCs on SWAYAM Portal	
MSc/EES/3/DSC4	Credit Seminar	2
MSc/EES/3/DSC5	Field visit (Industry/Institution/Insitu-Exsitu conservation site/Ecosystem)	2
MSc/EES/4/DSC6	Project/skill development/ In house training/Industrial training	2
	Total	**18**

Table 4: Skill Enhancement Courses offered by the Department of Energy and Environmental Sciences

MSc/EES/1/SEC1	Lab II-Environmental monitoring: Soil	**4**
MSc/EES/2/SEC2	Lab III-Environmental monitoring: Water	**4**
MSc/EES/3/SEC3	(A) Lab V- Environmental Microbiology	**4**
	(B) Lab V- Solid Waste	
	(C) Lab V- Practical aspects of Energy	
	Total	**12**

Table 5: Open elective Courses offered by the Department of Energy and Environmental Sciences

MSc/EES/9/OEC1	Environmental Awareness	4
MSc/EES/9/OEC2	Disaster Management	4
MSc/EES/9/OEC3	Environment and Society	4
	Total	**12**

3.4 Attainment Level

Table 1: CO-PO-PSO mapping matrix for all the courses offered by Department of Energy and Environmental Sciences

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
Semester-I												
MSc/EES/1/CC1	1.5	2	1.66	-	-	1.33	-	-	3	2	-	-
MSc/EES/1/CC2	2	2.25	2.25	2	2	1.5	1.5	1.25	2	2.5	2.75	`2.5
MSc/EES/1/CC3	2	2.25	2.25	2	2.5	2	3	2.25	2.25	2.5	2.75	2.5
MSc/EES/1/CC4	1.75	1.75	1.5	1.66	1	1.5		1.33	3	2.33	2	1.66
MSc/EES/1/CC5	2	2	2	2	2	1.25	3	3	2	2.5	2.75	2.75
MSc/EES/1/SEC1	2	1.5	2	-	2.5	1	3	3	2.5	2.25	2.5	2.75
Semester-II												
MSc/EES/2/CC6	1.75	2.25	2.5	2	1.25	1.25	1	2	1.75	1.25	2.25	1.5
MSc/EES/2/CC7	2.75	3	2	1.33	2	1	1	1	1	2	2	1.5
MSc/EES/2/CC8	2	1.5	1.75	-	1.5	1	3	3	3	2	3	3
MSc/EES/2/DSC1A	2.5	2.75	2.5	3	2.33	2	2.5	2.5	2.5	2.5	3	2.75
MSc/EES/2/DSC1B	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/DSC2 A	2	2	2	-	2.25	3	3	3	2.25	1.75	2.5	3
MSc/EES/2/DSC2 A	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/DSC3 A	2.25	1.25	1.25	1	1	2	2.5	2.75	1.5	2.5	2.75	3
MSc/EES/2/DSC3 B	1	2	3	3	2	2.33	2.33	2.33	1.25	1.5	1.25	2.75
MSc/EES/2/DSC3 C	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/SEC2	1.75	1.75	1.5	1.66	1	1.5	-	1.33	2	2.33	2	1.66
Semester-III												
MSc/EES/3/CC9	3	2.33	1.75	1.75	1.5	2	3	2.25	3	2.5	3	2.25
MSc/EES/3/CC10	1.66	1.5	2	2	1.25	2.75	1.5	2.25	2.33	2.25	2.25	3
MSc/EES/3/CC11	2.25	1.75	1.75	2.25	2	2.25	1	2.25	2	1.5	1.5	2.75
MSc/EES/3/CC12	-	1	1.66	-	-	1	-	1.75	2.33	2	2.5	1.75
MSc/EES/3/DSC4	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/3/SEC3 A	2	2	1.25	1	2	1.5	2	2.75	2	1.75	3	2
MSc/EES/3/SEC3 B	2	1	1	-	1.75	1	2.5	3	1	2.33	2.75	2.75
MSc/EES/3/SEC3 C	2	2	2.5	1	1.5	1	1.5	1.66	3	3	2.5	3
Semester-IV												
MSc/EES/4/CC13	2	2	2.5	1	1	1	1.5	1.66	3	3	2.5	3
MSc/EES/4/CC14	1.75	1.25	1.5	1	1.25	2	1	2	1	2.75	1.25	1.75
MSc/EES/4/CC15	2	2	2	-	1.66	2	2.25	2.25	1.75	2	2.25	3

MSc/EES/4/CC16	1.75	2.25	2.33	2.33	1.66	2.33	2.66	2.25	3	1.33	2.75	2.5
MSc/EES/4/CC17	2	2	2	1	2	1.75	2	3	1.25	1.25	2	2.75
MSc/EES/4/DSC5	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/3/DSC6	-	-	-	-	-	-	-	-	-	-	-	-

3.4.1 Attainment of COs:

Table 2: CO Attainment Levels for a Semester Examination of a course

Attainment Level	
1 (Low level of attainment)	50% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
2 (Medium level of attainment)	60% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
3 (High level of attainment)	70% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.

The CO attainment level for all the courses of the program can be obtained in a similar manner.

3.4.2 Calculation of Attainment values of POs and PSOs:

PO attainment value (for example for PO1) for a course (e.g. CC1) can be obtained as follows:

$$AVfor\ PO1 = \frac{(MFCPO1)X\ \ CO\ attainment\ value\ for\ the\ course\ CC1\ (as\ per\ table\ 2)}{3}$$

Where, AV = Attainment value

MFCPO1 = Mapping factor for course CC1 with PO1 as obtained from table 1

Likewise, PSO attainment value (for example for PSO1) for a course can be obtained as follows:

$$AV\text{for PSO1} = \frac{(MFCPSO1)X\ \text{CO attainment value for the course(as per table 2)}}{3}$$

Where, AV = Attainment value

MFCPSO1 = Mapping factor for a course with PSO1 as obtained from table 1

After finding the attainment values of each PO and PSO for various courses, we may write them in table form as given below:

Table 2: The calculated PO and PSO Attainment Values for all the courses

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
Semester-I												
MSc/EES/1/CC1	1.5	2	1.66	-	-	1.33	-	-	3	2	-	-
MSc/EES/1/CC2	2	2.25	2.25	2	2	1.5	1.5	1.25	2	2.5	2.75	`2.5
MSc/EES/1/CC3	2	2.25	2.25	2	2.5	2	3	2.25	2.25	2.5	2.75	2.5
MSc/EES/1/CC4	1.75	1.75	1.5	1.66	1	1.5		1.33	3	2.33	2	1.66
MSc/EES/1/CC5	2	2	2	2	2	1.25	3	3	2	2.5	2.75	2.75
MSc/EES/1/SEC1	2	1.5	2	-	2.5	1	3	3	2.5	2.25	2.5	2.75
Semester-II												
MSc/EES/2/CC6	1.75	2.25	2.5	2	1.25	1.25	1	2	1.75	1.25	2.25	1.5
MSc/EES/2/CC7	2.75	3	2	1.33	2	1	1	1	1	2	2	1.5
MSc/EES/2/CC8	2	1.5	1.75	-	1.5	1	3	3	3	2	3	3
MSc/EES/2/DSC1A	2.5	2.75	2.5	3	2.33	2	2.5	2.5	2.5	2.5	3	2.75
MSc/EES/2/DSC1B	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/DSC2 A	2	2	2	-	2.25	3	3	3	2.25	1.75	2.5	3
MSc/EES/2/DSC2 A	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/DSC3 A	2.25	1.25	1.25	1	1	2	2.5	2.75	1.5	2.5	2.75	3
MSc/EES/2/DSC3 B	1	2	3	3	2	2.33	2.33	2.33	1.25	1.5	1.25	2.75
MSc/EES/2/DSC3 C	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/2/SEC2	1.75	1.75	1.5	1.66	1	1.5	-	1.33	2	2.33	2	1.66
Semester-III												
MSc/EES/3/CC9	3	2.33	1.75	1.75	1.5	2	3	2.25	3	2.5	3	2.25

MSc/EES/3/CC10	1.66	1.5	2	2	1.25	2.75	1.5	2.25	2.33	2.25	2.25	3
MSc/EES/3/CC11	2.25	1.75	1.75	2.25	2	2.25	1	2.25	2	1.5	1.5	2.75
MSc/EES/3/CC12	-	1	1.66	-	-	1	-	1.75	2.33	2	2.5	1.75
MSc/EES/3/DSC4	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/3/SEC3 A	2	2	1.25	1	2	1.5	2	2.75	2	1.75	3	2
MSc/EES/3/SEC3 B	2	1	1	-	1.75	1	2.5	3	1	2.33	2.75	2.75
MSc/EES/3/SEC3 C	2	2	2.5	1	1.5	1	1.5	1.66	3	3	2.5	3
Semester-IV												
MSc/EES/4/CC13	2	2	2.5	1	1	1	1.5	1.66	3	3	2.5	3
MSc/EES/4/CC14	1.75	1.25	1.5	1	1.25	2	1	2	1	2.75	1.25	1.75
MSc/EES/4/CC15	2	2	2	-	1.66	2	2.25	2.25	1.75	2	2.25	3
MSc/EES/4/CC16	1.75	2.25	2.33	2.33	1.66	2.33	2.66	2.25	3	1.33	2.75	2.5
MSc/EES/4/CC17	2	2	2	1	2	1.75	2	3	1.25	1.25	2	2.75
MSc/EES/4/DSC5	-	-	-	-	-	-	-	-	-	-	-	-
MSc/EES/3/DSC6	-	-	-	-	-	-	-	-	-	-	-	-
Open Elective Courses												
MSc/EES/9/OEC1	2	2.25	2.25	2	2.5	2	3	2.25	2.25	2.5	2.75	2.5
MSc/EES/9/OEC2	1.5	1.66	1.33	1	2	2	-	2.33	2.5	2	1.5	1.5
MSc/EES/9/OEC3	1	1.75	1.25	-	2	2	-	1	1.25	2	2.25	2.25
Average of above values	**1.86**	**1.89**	**1.90**	**1.24**	**1.63**	**1.69**	**1.71**	**2.11**	**2.12**	**2.14**	**2.28**	**2.26**

The attainment of POs and PSOs is the average of individual PO and PSO attainment values. The PO and PSO attainment values obtained above are compared with set target. The set target for each PO and PSO may be different and can be finalized by the staff councils of the departments/institutes as described in the following table:

Table 3: PO and PSO Attainment Values and Set Target values

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
PO attainment values	**1.86**	**1.89**	**1.90**	**1.24**	**1.63**	**1.69**	**1.71**	**2.11**	**2.12**	**2.14**	**2.28**	**2.26**
Target Values	2	1.5	2	2	1.5	2	1.5	1.5	2	2	2	2

If PO and PSO attainment value is less than the set target value then an action plan may be prepared for improvement in the subsequent academic session.

CHAUDHARY DEVI LAL UNIVERSITY SIRSA
DEPARTMENT OF ENERGY AND ENVIRONMENTAL SCIENCES

SCHEME OF EXAMINATION FOR M.Sc. ENVIRONMENTAL SCIENCE

SEMESTER	CORE COURSES (CC)	DISCIPLINE SPECIFIC AND SKILL SPECIFIC ENHANCEMENT COURSES (DSC & SEC)	TOTAL	TOTAL MARKS
I	20	04	24	600
II	12	16	28	700
III	16	08	24	600
IV	20	02	22	550
TOTAL	**68**	**30**	**98**	**2450**
The students have to earn 10% of the programme credit from open elective courses				

Open Elective Courses (OEC) for the Students of M.Sc. Environmental Science

The student will earn minimum ten percent of the programme credits by choosing open elective courses offered by different departments of the university other than the Department of Energy and Environmental Sciences.

GENERAL INSTRUCTIONS:

1. The Project/skill development/In House Training/ Training Industrial (one year/Duration 3-8 week during summer vacation after 2nd semester) (MSc/EES/3/DSC6) of 2 credits will be evaluated in fourth semester by a committee of internal faculty members.
2. The Field report (MSc/EES/4/DSC5) of 2 credits will be in fourth semester. The evaluation of the Field report will be done in fourth semester by a committee of internal faculty members
3. The ordinance of Choice Based Credit System (CBCS) of the university will be followed by the department.
4. The departmental elective courses (EC) will be allotted to the students on the basis of their preference and percentage of marks in the previous semesters of M.Sc. Environmental Science
5. The evaluation of courses shall be as under:

Project/training evaluation criteria: Relevance, need and clarity in the objectives; the originality and quality of the content; quality of presentation; subject knowledge and presentation viva; time line of completion of project; continuous evaluation by the guide.

Open Elective Courses for the Students of other departments of the university

The department of Energy & Environmental Sciences will offer the following open elective course for the students of other departments of the university in both the odd and even semesters.

Open Elective Courses (OEC)

S. NO.	COURSE CODE	TITLE	TEACHING HOURS	CREDIT (TH+T)	EXAMINATION SCHEDULE		DURATION OF EXAM
					TH	Int. Assess	
1	**MSc/EES/9/OEC 1**	Environmental Awareness	OE (4)	4 +1	70	30	3
2	**MSc/EES/9/OEC 2**	Disaster Management	OE (4)	4 +1	70	30	3
3	**MSc/EES/9/OEC 3**	Environment and Society	OE (4)	4 +1	70	30	3

Evaluation of Courses

Theory Courses components	Weightage (4 credits)	Weightage (3 credits)	Weightage (2 credits)	Evaluation
Mid term	20	15	10	Internal
Assignment	05	05	05	Internal
Attendance	05	05	05	Internal
End term exam	70	50	30	External
Total	100	75	50	

Semester wise distribution of courses and their details

M.Sc. Environmental Science (First Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours	Exam marks		Duration of Exam
				L TP	TH	IA	
1	MSc/EES/1/CC1	Earth Processes and natural disaster	CC (4)	4 1	70	30	3
2	MSc/EES/1/CC2	Ecology	CC(4)	4 1	70	30	3
3	MSc/EES/1/CC3	Environmental Chemistry	CC(4)	4 1	70	30	3
4	MSc/EES/1/CC4	Physical Environment	CC(4)	4 1	70	30	3
5	MSc/EES/1/CC5	Lab I-Ecology	CC(4)	(4+4) 2 days & 2 groups	100		6
6	MSc/EES/1/SEC1	Lab II-Env Monitoring: Soil	SEC (4)	(4+4) 2 days & 2 groups	100		6
		Total	**CC(20)+ SEC (4) = 24**				
				8X2=16x2=32	**600**		

M.Sc. Environmental Science (Second Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours	Exam marks		Duration of Exam
				L T P	TH	IA	
1	MSc/EES/2/ CC6	Biodiversity and Environmental issues	CC(4)	4 1	70	30	3
2	MSc/EES/2/ CC7	Environmental Pollution	CC(4)	4 1	70	30	3
3	MSc/EES/2/ DSC1 (A)/ MSc/EES/2/ DSC1 (B)/	Environmental Impact Assessment/ MOOCs on SWAYAM Portal	DSC (4)	4 1	70	30	3
4	MSc/EES/2/ DSC2 (A)/ MSc/EES/2/ DSC2 (B)	Analytical Techniques/ MOOCs on SWAYAM Portal	DSC (4)	4 1	70	30	3
5	MSc/EES/2/ DSC3 (A)/ MSc/EES/2/ DSC3 (B)/ MSc/EES/2/ DSC3 (C)	Biostatistics & Computer Application/Academic integrity, Ethics & Biosafety / MOOCs on SWAYAM Portal	DSC (4)	4 1	70	30	3
6	MSc/EES/2/ SEC2	Lab III-Env Monitoring: Water	SEC (4)	(4+4) 2 days & 2 groups	100		6
7	MSc/EES/2/ CC8	Lab IV-Env Monitoring: Air & Noise	CC(4)	(4+4) 2 days & 2 groups	100		6
		Total	**CC(12), DSC (12), SEC (4) = 28**				
				8X2=16x2=32	**700**		

M.Sc. Environmental Science (Third Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours	Exam marks	Duration of Exam
				L T PR	TH IA	
1	MSc/EES/3/ CC9	Environmental Microbiology	CC(4)	4 1	70 30	3
2	MSc/EES/3/ CC10	Pollution Control & Management	CC(4)	4 1	70 30	3
3	MSc/EES/3/ CC11	Environmental Biotechnology	CC(4)	4 1	70 30	3
4	MSc/EES/3/ CC12	Environmental Law	CC(4)	4 1	70 30	3
5	MSc/EES/3/ SEC3 (A)/ MSc/EES/3/ SEC3 (B)/ MSc/EES/3/ SEC3 (C)	Lab V-Env. Microbiology/ Lab V-Solid Waste/ Lab V- Practical aspects of Energy	SEC (4)	(4+4) 2 days & 2 groups	100	6
6	MSc/EES/3/ DSC4	Credit Seminar	DSC (2)	2XN (Number of faculty members)	50	To be evaluated by faculty members
7	MSc/EES/3/ DSC5	Field Visit(Industry/ Institution/Insitu-Exsitu conservation site/ Ecosystem)	DSC (2)		50	To be evaluated by committee of internal faculty members
		Total	**CC(16)+ DSC (4) + SEC (4) = 24**		**600**	
				8X3=24x2=48		

M.Sc. Environmental Science (Fourth Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours	Exam marks	Duration of Exam
				L T PR	TH IA	
1	MSc/EES/4/CC13	Energy Resources	CC(4)	4 1	70 30	3
2	MSc/EES/4/CC14	Environmental Health & Toxicology	CC(4)	4 1	70 30	3
3	MSc/EES/4/CC15	Remote sensing & Modelling	CC(4)	4 1	70 30	3
4	MSc/EES/4/CC16	Natural Resource Management	CC(4)	4 1	70 30	3
5	MSc/EES/4/CC17	Lab VI-Environmental Biochemistry	CC(4)	(4+4) 2 days & 2 groups	100	6
6	MSc/EES/4/DSC6	Project/skill development/In House Training/ Industrial Training (Duration 3-8 week during summer vacation after 2nd semester)	DSC (2)	#Project/skill development/In House Training/ Industrial Training	50	To be evaluated in fourth semester by committee of internal faculty members
		Total	**CC(20)+ DSC (2) = 22**		**550**	
				8X2=16x2=32		

[#] 2 hours/ week as contact hours in case of Project/skill development/In House Training/ Industrial Training

COURSE CODE: MSc/EES/1/CC1

COURSE TITLE: EARTH PROCESSES AND NATURAL DISASTERS

Credit: 4 **Marks: 100**

Exam. Duration: 3 Hrs **Theory+Internal assessment: 70+30**

COURSE OBJECTIVES:

This course aims to provide schmick information and knowledge on various fundamental aspects of geology and constructive and deformative geological processes operational on the earth and mineral resources of India. This course also gives opportunity for the students to learn about fundamentals, impact and mitigation measures for different types of natural disaster and also develop skill to learn from earlier disasters in order to formulate better strategies for mitigation in future circumstances.

COURSE OUTCOMES:

After completion of the course, the student will be able:

CO1: To understand the various aspects of the Earth evolution through geologic time, primary differentiation, and element distribution. Student also the understand richness of the mineral resources of India.

CO2: To explain different types of rock and their characteristics during the rock cycle.

CO3: To explain the principle and phenomenon of tectonic movement and associated geographical features like mountains, sea, fault, etc. Student also explain the fundamental, mechanism, impact and mitigation aspects about different geological hazards and disaster.

CO4: To explain the fundamental, mechanism, impact and mitigation aspects about various climatic hazards and disaster. Student also understand process of disaster management and role of different agencies, society, legal support for the disaster management.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Origin of the universe; Origin and evolution of Earth; Primary geochemical differentiation and formation of crust, mantle, core, atmosphere and hydrosphere; Geological time scale; Geochemical classification of elements; Mineral resources of India

UNIT II **14 Hours**

Concept of minerals and rocks; Magma generation; Formation, characteristics, and types of rock: Igneous, Sedimentary, and Metamorphic; Rock cycle; Weathering; Erosion, transportation, and deposition of earth's materials by running water, winds, and glaciers.

UNIT III **14 Hours**

Concept of plate tectonics; Isostasy; Theory of continental drift; Paleomagnetism; Faults; Seafloor spreading; Mountain building: Island arc, Andes, Himalaya; Earthquake; Avalanches; Landslides; Volcano; Tsunami; Uttarakhand Disaster.

UNIT IV **15 Hours**

Climatic hazards and disaster: Tropical Cyclones, Western disturbances and Winter Rains in India, Anticyclones, Blizzards, Windstorms, Hail storms, Cloud burst, Floods, Drought, El-Nino, La-Nina. National and International efforts for disaster management, Impact of hazards on human and environment.

Suggested readings:

1. Keller, E.A. (2012) *Introduction to Environmental Geology*, Pearson.
2. Montogomery, C. (2010) *Environmental Geology*, Mcgraw-Hill Education
3. Lutgens, F.K., Tarbuck, E. and Tasa, D.G. (2018) *Essentials of Geology*, Pearson
4. Jetli, K.N. (2011) *Mineral resources and policy in India*, New Century Publication.
5. Ramakrishnan, M. and Vaidyanadhan, R. (2008) *Geology of India Vol. 2*, Geological Society of India.
6. Hyndman, D. and Hyndman, D. (2016) *Natural Hazards and Disasters*,Thomson Brooks/Cole.
7. Singh, J. (2008) *Disaster management*, APH Publishing Corporation.
8. Pipkin, B.W., Trent, D.D., Hazlett, R. and Bierman, P. (2014) *Geology and the Environment*, Cengage.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/1/CC1

MSc/EES/1/CC1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	2	-	-	-	-	-
CO2	-	2	1	-	-	1	-	-
CO3	1	-	-	-	-	1	-	-
CO4	2	2	2	-	-	2	-	-
Average	1.5	2	1.66	-	-	1.33	-	-

CO-PSO MAPPING for MSc/EES/1/CC1

MSc/EES/1/CC1	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	3	-	-	-
CO3	3	-	-	-
CO4	3	-	-	-
Average	3	2	-	-

COURSE CODE: MSc/EES/1/CC2
COURSE TITLE: ECOLOGY

Credit: 4 **Marks: 100**
Exam. Duration: 3 Hrs **Theory+Internal assessment: 70+30**

COURSE OBJECTIVES:

The aim of this course is to make students understand the basic concepts of ecology, structure and function of ecosystems and concepts of energy flow, biogeochemical cycles, community ecology and succession. The students will develop understanding of concepts of ecosystem development and significance of biotic interactions and ecosystem stability.

COURSE OUTCOMES:

After completion of the course, the student will be able to:

CO1: Exposed to the fundamental aspects of ecology.

CO2: Students will have in-depth knowledge about biotic and abiotic factors that are related to individual, population, community and ecosystem, as well as interrelationships.

CO3: The students will understand and be able to analyse evolutionary changes and environmental adaptations.

CO4: Students will have in-depth knowledgeabout community ecology and the concept of ecological succession.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **14 Hour**

Introduction: Definition, aims and scope of Ecology, Application and branches of Ecology, Organization level of biosphere, Ecological factors, Liebig's law of minimum, Shelford's law of Tolerance, other limiting factors.

UNIT II **15 Hours**

Ecosystem: Structure, Function and Services, Ecological pyramids, Food webs, Tropic levels, Ecological efficiencies, Model of energy flow, Energy budget, Primary and secondary production. Biogeochemical cycle: Gaseous cycles and Sedimentary Cycles, Human impact on biogeochemical cycling.

UNIT III **14 Hours**

Population Ecology: Demography, Population characteristics, Evolutionary strategy, r and k selection, Population growth and Regulation, Human population dynamics, Age structure, Population interaction, Symbiotic association, Competition, Parasitism, Prey-predator Relations.

UNIT IV **15 Hours**

Community Ecology: Community Ecology, Analytical and Synthetic characters, Species diversity, Biomes and their types, Concept of niche, Keystone species, Ecad, Ecotype, Ecotone and Edge effect, Endemic species, Ecological succession: Types, trends and models, concept of climax

Suggested readings:

1. Brewer, R. (1994) *The Science of Ecology*, Sanders College Publishing Co.
2. Lieth, H. and Whittaker, R.H. (1975) *Primary Productivity of the Biosphere.* Springer-Verlag.
3. Odum, E.P and Barrett, G.W. (2004) *Fundamentals of Ecology*, Thomson Brooks/Cole.

4. Odum, E.P. (2008) *Basic Ecology*, W.B. Saunders.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015) *Ecology, Environment and Resource Conservation,* Sultan Chand Publishing.
6. Smith, R.L. (1996) *Ecology and Field Biology*, Harper Collins.
7. Michael, P.N. (2018) *Ecology*, CBS Publisher and Distributors.
8. Miller G.T. and Spoolman S.E. (2009) *Essentials of Ecology*, Cengage.
9. Smith T.M. and Smith R.L. (2012) *Elements of Ecology*, Pearson.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/1/CC2

MSc/EES/1/CC2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	3	2	-	-	2	2
CO2	2	3	1	2	2	2	1	1
CO3	3	1	2	-	3	1	-	-
CO4	2	3	3	2	1	-	-	1
Average	2	2.25	2.25	2	2	1.50	1.50	1.25

CO-PSO MAPPING for MSc/EES/1/CC2

MSc/EES/1/CC2	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	1	-	3	3
CO3	2	-	3	3
CO4	2	2	3	2
Average	2	2.5	2.75	`2.5

COURSE CODE: MSc/EES/1/CC3
COURSE TITLE: ENVIRONMENTAL CHEMISTRY

Credit: 4 **Marks: 100**
Exam. Duration: 3Hrs **Theory+Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to acquaint the student about the chemical composition of the different components of the environment (air, water, soil) and their subsequent interaction with biotic and abiotic components.

COURSE OUTCOMES:

After completion of the course, the student will be

CO1: Able to explain the chemical nature and interaction of the air, water and soil and their characteristic features for survival growth of biota.

CO2: Able to apply analytical tools to determine and measure pollutants in various environmental components.

CO3: Able to characterize water quality parameters and get knowledge about water quality standards for consumption of living beings.

CO4: Able to analyze& apply the concept of thermodynamics, laws and heat transformation processes in different spheres of environment.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Atmospheric Chemistry: Chemical composition of the atmosphere-particles, ions, and radicals, Formation of particulate matter, Photochemical and chemical reaction in the atmosphere, Smog, Acid rain, Chemistry of Ozone layer depletion, Global warming, and Greenhouse effect.

UNIT II **15 Hours**

Water Chemistry: Water quality parameters (Physical, chemical & biological parameters) and their quality standards for drinking and irrigation; Chemistry of inland water bodies (lentic system, lotic system); Solubility of gases in water, Carbonate system, Redox potential, Solubility product, Acids- Base reaction.,

UNIT III **15 Hours**

Soil Chemistry: Chemical and mineralogical composition, Soil formation, soil profile, Soil properties (physical, chemical, biological), soil nutrients (Organic and Inorganic nutrients), Ion exchange reactions in soil, soil fertility, soil pollutants (Pesticides, Heavy metals) and their effects.

UNIT IV **15 Hours**

Thermodynamics: Classification of elements, Stoichiometry; First law of thermodynamics, Enthalpy, Second law of thermodynamics, Carnot's cycle, Entropy. Third law of thermodynamics, Gibb's free energy, Chemical equilibrium and chemical potential.

Suggested readings:

1. Ahluwalia, V.K. (2017) *Advance Environmental Chemistry*, Teri Press Publisher.
2. Botkin, D.B. and Keller E.A. (2004) *Environment Science: Earth as a Living Plant*. John Wiley & Sons Inc.
3. Connell, D.W. (2005) *Basic Concept of Environmental Chemistry*, CRC Press.
4. Weiner, E.R. (2013) *Application of Environmental Aquatic Chemistry: A practical guide*, CRC Press.
5. Subramanian, V. (2011) *A Text Book Environmental Chemistry*, International Publishing House.
6. Manahan, S. and Manahan, S.E. (2009) *Environmental Chemistry*, CRC Press.
7. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015) *Ecology, Environment and Resource Conservation*, Sultan Chand Publishing.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/1/CC3

MSc/EES/1/CC3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	2	3	-	-	-	2
CO2	3	3	2	1	2	2	3	2
CO3	2	1	3	3	3	2	3	3
CO4	2	2	2	1	-	-	-	2
Average	2	2.25	2.25	2	2.5	2	3	2.25

CO-PSO MAPPING for MSc/EES/1/CC3

MSc/EES/1/CC3	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	2	3	3	3
CO3	2	2	3	3
CO4	2	2	3	2
Average	2.25	2.5	2.75	2.5

COURSE CODE: MSc/EES/1/CC4
COURSE TITLE:PHYSICAL ENVIRONMENT

Credit: 4 **Marks: 100**

Exam.Duration: 3Hrs **Theory+Internal assessment: 70+30**

COURSE OBJECTIVES:

This course provides information about the two main physical realms of the environment, i.e. atmosphere and hydrosphere, along with their interactions and phenomenon. This course gives opportunity for the students to learn about the atmosphere's composition, structure, pressure, stability, interaction with solar radiations, and other meteorological phenomenon. Also, the students will get to know about the aquatic ecosystems.

Course Outcomes:

On successful completion of this course, the students will be able:

CO1: To acquire the knowledge and understanding of structure, functions and distribution of different constituents of the atmosphere.

CO2: To understand the earth and sun relationship, the complex interaction of solar radiation with the earth's atmosphere, different mechanisms controlling earth's heat budget, and will be able to appraise how various natural and anthropogenic factors control and modify the earth's climate.

CO3: To gather information about various parameters of meteorology and be able to predict their role in weather prediction and climate science.

CO4: To classify the various hydrological / aquatic systems and learn about their composition, functions and different processes occurring within them.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Earth Atmosphere: Composition of Atmosphere, Atmospheric composition as a function of height, Thermal structure of atmosphere, Lapse rates and its types, Concept of Air Parcel, Vertical stability of atmosphere, Inversions, Mixing Height, Atmospheric stability and Plume behavior, Hydrostatic equilibrium.

UNIT II **15 Hours**

Earth Sun Relations: Relationship between earth and sun, Latitudinal and seasonal distribution of Insolation, Solar radiation, Interaction of solar radiation with atmosphere, Terrestrial radiation, Atmospheric window, Albedo, Planetary Albedo, Heat budget of the earth, History of climate change, Methods for climate change detection, Milankovitch's theory of climatic change, Climatic feedback mechanism,

UNIT III **15 Hours**

Meteorology: Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, wind velocity, Coriolis force, pressure gradient force, Global pressure belt systems, Cloud formation and classification, Precipitation, South-Westerly and North-Easterly Monsoon and its patterns.

UNIT IV **15 Hours**

Aquatic Ecosystems: Limnology- Physicochemical properties of Water, Types of freshwater bodies lentic and lotic; water mixing in lakes; Oceanography- Origin and Composition of sea water, Variation in Sea water Salinity and pH, Marine Biozones, Ocean waves and currents, Marine geological environment, Marine sediments.

Suggested Readings:

1. Lutgens, F.K., Tarbuck, E.J. and Tasa, D.G. (2016) *The atmosphere: An introduction to Meteorology*, Pearson.
2. Wallace, J.M. and Hobbs, P. (2006) *Atmospheric Science: An Introductory Survey*, Elsevier.
3. Mintzer, I.M. (1992) *Confronting climate change: Risks, Implications and Responses*, Cambridge University Press.
4. Critchfield H.J. (2008) *General climatology*, PHI learning.
5. Garrison, T. and Ellis, R. (2015) *Essentials of Oceanography*, Cengage Learning, Inc.
6. Thurman, H.V. and Trujillo, A.P. (2016) *Essentials of Oceanography*, Pearson.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations, E-tutoring & E- learning, case study, cooperative learning, problem solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/1/CC4

MSc/EES/1/CC4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	2	-	-	2	-	-
CO2	2	2	1	2	-	1	-	1
CO3	2	1	1	1	-	1	-	2
CO4	2	2	2	2	1	2	-	1
Average	1.75	1.75	1.5	1.66	1	1.50	-	1.33

CO-PSO MAPPING for MSc/EES/1/CC4

MSc/EES/1/CC4	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-
CO2	3	3	-	2
CO3	3	-	-	1
CO4	3	1	2	2
Average	3	2.33	2	1.66

COURSE CODE: MSc/EES/1/CC5
COURSE TITLE: LAB I- ECOLOGY

Credit : 4 **Marks: 100**
Practical Hrs: 4 + 4 **Exam duration: 6 hrs**

COURSE OUTCOMES:
After completion of the course, the student will be able to
CO1: Determine Biomass Estimation of Plant Sample.
CO2: Determine the population density and Species richness and evenness (Biodiversity) by quadrate method.
CO3: Determine the Frequency and abundance of a plant community by quadrate method.
CO4: Determine the Importance Value Index (IVI) of species by quadrate method.

1. Biomass Estimation of Plant Sample.
2. Determination of minimum size of the quadrate.
3. Determination of minimum numbers of the quadrate.
4. Determination of population density by quadrate method.
5. Species richness and evenness (Biodiversity) by quadrate method.
6. Determination of Frequency of a plant community by quadrate method.
7. Determination of Abundance of a plant community by quadrate method.
8. Determination of Relative Dominance of plant community by quadrate method.
9. Determination of Importance Value Index (IVI) of species by quadrate method.

CO-PO MAPPING for MSc/EES/1/CC5

MSc/EES/1/CC5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	-	3	2	-	1	3	3
CO2	2	-	1	2	2	2	3	3
CO3	3	1	2	-	3	1	3	3
CO4	2	3	3	2	1	1	3	3
Average	2	2	2	2	2	1.25	3	3

CO-PSO MAPPING for MSc/EES/1/CC5

MSc/EES/1/CC5	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	1	-	3	3
CO3	2	-	3	3
CO4	2	2	2	3
Average	2	2.5	2.75	2.75

COURSE CODE: MSc/EES/1/SEC1
COURSE TITLE:LAB II - ENVIRONMENTAL MONITORING: SOIL

Credit: 4 **Marks: 100**
Practical Hrs: 4 + 4 **Exam duration: 6 hrs**

Course Outcomes: After completion of this course, the students will be able to:

CO1: Design soil sampling plans for monitoring and research

CO2: Analyse different physio-chemical parameters for soil and rock samples.

CO3: Demonstrate key practical skills in working with soil and rock matrices in laboratory.

CO4: Design various experiments for analysing the pollutants in soil and rock matrices.

1. Soil Sampling and Sample processing.
2. Determination of pH in soil sample.
3. Determination EC in soil sample.
4. Determination of Carbonate content in soil sample.
5. Determination of Total Organic Carbon (TOC) in soil sample.
6. Determination of Particle Size Analysis (PSA) in soil sample.
7. Mineralogical analysis of soil and rock samples.
8. Heavy metal analysis of soils.
9. Determination of water holding capacity of soil sample.
10. Determination of different forms of Nitrogen by Kjeldahl method.

CO-PO MAPPING for MSc/EES/1/SEC1

MSc/EES/1/SEC1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	-	2	1	3	3
CO2	2	1	-	-	3	-	3	3
CO3	2	1	-	-	3	-	3	3
CO4	2	2	2	-	2	1	3	3
Average	2	1.5	2	-	2.5	1	3	3

CO-PSO MAPPING for MSc/EES/1/SEC1

MSc/EES/1/SEC1	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	3	3
CO3	2	2	2	3
CO4	2	1	3	2
Average	2.5	2.25	2.5	2.75

COURSE CODE: MSc/EES/2/CC6

COURSE TITLE: BIODIVERSITY AND ENVIRONMENTAL ISSUES

Credit: 4 **Marks: 100**

Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to acquaint the student about the concept and significance of biodiversity, Bio-geographical zones, Red data book, conservation strategies and methods, protected area network, and restoration of biodiversity.Students also acquaint the major national and international environmental Issues along with the conservation strategies. Student will also knowledge about different programme, treaty and protocols to deal the issues

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: Explain the concept and significance of biodiversity and will have an overview of the biological and agro diversity of India.Student also understand the role of international agencies and will have better understanding of Red data book along with its categories and concept of Hotspot.

CO2: understand the concept and strategies of biodiversity conservation and will have better understanding of concept and types of Protected area network in the country.Students also understand the role of national agencies in conservation of Biodiversity and will have better understanding of different concepts needed for achieving the sustainable development goals.

CO3: Will get knowledge about different international treaties, panel and programmes.

CO4: Students will acquire knowledge about the National Issues associated with water pollution and will also be able to appreciate the various social moments in environmental conservation.They also become familiar with Government of India's initiative for conservation of rivers, wetlands and animals.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **14 Hours**

Biodiversity: Definition, Significance, Threats, Genetic variability, global and Indian status of biodiversity, Floral, Faunal and Microbial Diversity in India, Agro-diversity in India. Forest wealth of India, Biogeographical zones of India,IUCN, Concept of Red Data Book, and Red list Categories, concept of species extinction, Mega diversity regions of the world, Concept of Biodiversity Hotspot, Global Biodiversity Hotspots, Biodiversity Hotspots in India.

UNIT II **14 Hours**

Natural initiative for biodiversity conservation: Biodiversity conservation strategies: In situ conservation, Protected Area Network, National Parks, Sanctuaries and Biosphere reserves in India, Ramsar wetland sites in India and Ex-situ conservation, Botanical garden, Zoological Garden, aquarium, Concept of Gene bank, Gene banks in India, Sustainable Development: -concept and goals associated with biodiversity, National initiatives for the conservation of biodiversity. National Biodiversity Authority, Bioprospecting, Biopiracy. Concept of Exotic, Invasive and Endemic species.

UNIT III **15 Hours**

International issues and initiatives:- Climate Change, Transboundary Movement of Pollutants, The Club of Rome report, United Nations Conference on the Human Environment (Stockholm Declaration 1972), Agenda

21, WCS (World Conservation Strategy), IGBP(International Geosphere Biosphere Programme) Outer Space treaty, Vienna convention & Montreal Protocol, Kyoto Protocol, united nations Conference on Environment and Development- Rio Convention (Earth Summit 1992), Antarctic Treaty, IPCC (Inter-governmental panel for Climate change), UNFCCC(United Nations Framework Conventions of Climate Change).

UNIT IV **14 Hours**

National issues and initiatives: Desertification, Deforestation. Mass movement for Environmental conservation: Narmada BachaoAndolan, Tehri Movement, Chipko Movement, Appiko Movement, Silent Valley.National River Conservation Directorate, National Ganga River basin authority.

Suggested readings

1. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015) *Ecology, Environment and Resource Conservation*, Sultan Chand Publishing.
2. Miller, T.J. and Spoolman (2009) *Essential of Ecology*, Cengage learning.
3. Pellens, R. and Grancolas, P. (2016) *Biodiversity conservation and Phylogenetic Systematics*, Springer.
4. Patterson, R. and Lima, N. (2017) *Bioprospecting: Success, Potential and Constraints*. Springer.
5. Sorokhtin, O.G., Chilingar, G.V. and Khilyuk, L.F. (2007) *Global warming and global cooling: Evolution of climate and earth,* Elsevier.
6. Steffen, W., Sanderson A., Tyson P.D., Jager J., Matson P.M., Moore B., Oldfield F., Richardson K., Schnellnhuber H.J., Turner B.L. and Wasson R.J. (2004). *Global change and the Earth system: a Planet under Pressure*, Springer-Verlag.
7. Botkin, D.B. and Keller, E.A. (2004) *Environment Science: Earth as a Living Planet*. John Wiley & Sons Inc.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/CC6

MSc/EES/2/CC6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	1	1	--	--
CO2	2	2	2	1	1	1	--	2
CO3	2	3	3	2	1	1	1	--
CO4	1	2	2	3	2	2	--	2
Average	1.75	2.25	2.5	2	1.25	1.25	1	2

CO-PSO MAPPING for MSc/EES/2/CC6

MSc/EES/2/CC6	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1
CO2	1	1	2	2
CO3	2	2	3	2
CO4	2	--	2	1
Average	1.75	1.25	2.25	1.5

COURSE CODE: MSc/EES/2/CC7
COURSE TITLE: ENVIRONMENTAL POLLUTION

Credit: 4 **Marks: 100**
Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The aim of this course is to impart knowledge to the students about the sources and fate of various pollution i.e., air, water, soil and noise and their impacts on human and environment along with remedies.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To explain the various sources, and fate of different water pollutants along with their effects on environment.

CO2: To explain the various sources, and fate of different air pollutants and their effects on environment.

CO3: To explain the various types and sources of soil pollutant along with their effects on environment and remedies.

CO4: To explain the various fundamental aspects associated with noise pollutants and their effects on environment.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Water pollution: Sources, Consequences, Ecological and Biochemical aspects of water pollution, Characteristic of domestic, industrial, and agricultural wastes, their effect on water bodies, Water quality parameters, Criteria and standards. Marine pollution, Thermal pollution.

UNIT II **14 Hours**

Air pollution: sources, Classification and properties of air pollutant, Behavior fate of air pollutant, Effect of air pollution on human health and materials, Air pollution meteorology.

UNIT III **15 Hours**

Soil pollution: Soil pollution form the use of Fertilizers, Pesticides, Heavy metals, Industrial effluent and surfactant. Detrimental effects of soil pollutant, Soil sediment as pollutant, Remedial measures for soil pollution.

UNIT IV **15 Hours**

Noise pollution: Definition, Sound pressure level, noise spectra, Octave band. Frequency, Weighting network, noise monitoring and sound level meter, equivalent continuous noise level, Effects of noise pollution.

Suggested readings:

1. Bell L.H. and Bell D.H. (1994) *Industrial Noise Control: Fundamentals and Applications*, CRC Press.
2. Masters, G.M., Ela, W., and Ela, W.P. (2013) *Introduction to Environmental Engineering and Science*, Pearson.
3. Aswathanarayan, U. (2018) *Geoenvironment*, CRC Press.
4. Bolt, G.H. and Buggenwert, M.G.M (1979) *Soil Chemistry*, Elsever.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/CC7

MSc/EES/2/CC7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	2	1	1	1
CO2	3	3	2	1	2	1	1	1
CO3	3	3	2	-	2	1	1	1
CO4	2	3	2	1	2	1	1	1
Average	2.75	3	2	1.33	2	1	1	1

CO-PSO MAPPING for MSc/EES/2/CC7

MSc/EES/2/CC7	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	1
CO2	1	2	2	1
CO3	1	2	2	2
CO4	1	2	2	2
Average	1	2	2	1.5

COURSE CODE: MSc/EES/2/DSC1

COURSE TITLE: ENVIRONMENTAL IMPACT ASSESSMENT

Credit: 4 **Marks: 100**

Exam. Duration: 3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to impart knowledge on basic understanding about Environmental Impact Assessment its process and methodology, get knowledge about the case studies of different development projects and their risk assessment aspect. The students will be enabling to know about how to apply concepts of EIA in environmental planning.

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: Explain the basics and legal aspects of Environmental Impact Assessment in developmental activities/projects.

CO2: Apply analytical tools like EIA processes and methodologies to determine and measure environmental impacts due to planning of developmental activities/projects.

CO3: Understand how to write EIA report in addition to be able to access different case studies/examples of EIA in real life practices.

CO4: Able to examine environmental risk by its analysis and assessment and management by understanding the steps involved.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Environmental Impact Assessment (EIA)- aims and objectives, Origin & Development of EIA, EIA Guidelines (1994), Indian directions of EIA, EIA legal notification of 2006; EIA amendment from time to time; Environmental planning as a part of EIA; Types of projects requiring Environmental Clearance, Scope of EIA in project planning and implementation, Environmental Management Systems, Environmental Management plan.

UNIT II **15 Hours**

EIA process- project screening, scoping, base line data, impact identification, and prediction, evaluation, monitoring, auditing and mitigation, public participation, presentation, review and decision making in EIA process; Environmental impact statement (EIS), EIA Assessment Techniques – cost benefit analysis, analysis of alternatives, methods of prediction- matrices, networks, checklists and overlays and assessment of impacts – air, water, soil, noise, biological, social, cultural, economic, environmental factors.

UNIT III **15 Hours**

EIA applications for sustainable development- Environmentally sound technologies; concept of cleaner production; clean development mechanism (CDM), Environmental management plan ISO-14000, Life Cycle Analysis (LCA), Strategic Environmental Assessment (SEA). Case studies: Environmental impact of mining industries; Environmental impact of power plants; Environmental impact of dams.

UNIT IV **15 Hours**

Environmental Risk: Definition of risk, nature of risk (voluntary and involuntary risk), risk perception, important environmental risk, risk assessment- hazard identification, exposure assessment, dose-response assessment and risk characterization; risk management- risk identification, risk estimation, risk evaluation

Suggested reading:

1 Chitkara. M.G. (2013)*Environmental Impact Assessment*, APH Publishing Corporation.

2 Glenn, W. and Suter II. (2007) *Ecological Risk Assessment*, CRC Press.

3 Kulharni, V. and Ramachandran, T.V. (2006) *Environmental Management*, Common Wealth of Learning and Indian Institute of Science.

4 Theodore, L. and Dupont, R.R. (2012) *Environmental Health and Hazard Risk Assessment- Principles and Calculations*. CRC Press.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/DSC1

MSc/EES/2/DSC1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	-	-	2	2
CO2	2	3	2	3	1	2	2	2
CO3	3	2	3	3	3	2	3	3
CO4	3	3	3	3	3	2	3	3
Average	2.5	2.75	2.5	3	2.33	2	2.5	2.5

CO-PSO MAPPING for MSc/EES/2/DSC1

MSc/EES/2/DSC1	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3
CO2	3	3	3	3
CO3	3	3	3	3
CO4	2	2	3	2
Average	2.5	2.5	3	2.75

COURSE CODE: MSc/EES/2/DSC2
COURSE TITLE:ANALYTICAL TECHNIQUES

Credit: 4 **Marks: 100**

Exam.Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The aim of this course is to give the students, knowledge of conventional and modern techniques for the analysis of biotic and abiotic components of environment, and various environmental pollutants using various spectroscopic, chromatographic and wet chemical analysis techniques. The students can apply the knowledge of these methods and techniques in research and analysis of environmental components.

COURSE OUTCOMES:

On successful completion of this course, the students will be able to:

CO1: Acquire knowledge about designing of sampling plans for water, air and soil monitoring and research

CO2: Use spectroscopic techniques to analyze various pollutants in environment and understand theory and techniques for the measurement of pollutants.

CO3: Demonstrate a broad and coherent knowledge and understanding of environmental analytical chemistry and spectroscopic and chromatographic instrumental methods of analysis.

CO4: Demonstrate key practical skills in working with water, air, soil and other environmental matrices in laboratory.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Environmental Sampling: Water, Air and Soil, High Volume Air Sampler, Cascade Impactor.Titrimetry: Complexometry, Neutralization titrations, Oxidation-Reduction Titrations.; Gravimetry, Electrophoresis.

UNIT II **15 Hours**

Spectroscopy: Principles of spectroscopy, UV-Visible spectrophotometry, Flame photometry, Atomic Absorption Spectroscopy, Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS).

UNIT III **15 Hours**

Chromatographic technique: Theory and Principle, Paper chromatography, Thin layer chromatography (TLC), Column chromatography, Ion exchange chromatography, Gas chromatography (GC), High Pressure Liquid Chromatography (HPLC).

UNIT IV **14Hours**

Fourier transform infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF)**,** Fluorometry.

Suggested Readings

1 Mendham, J., Denney, R.C., Barnes, J.D., Thomas, M. and Sivasankar, B. (2009) *Vogel's Textbook of Quantitative Chemical Analysis*, Pearson.
2 Chatwal, G.R. and Anand S.K. (2002) *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House.
3 Robinson, J.W., Frame, E.M.S. and Frame, G.M. (2005) *Undergraduate instrumental analysis*, Marcel Dekker.
4 Rouessac, F. and Rouessac, A. (2007) *Chemical Analysis: Modern Instrumentation Methods and Techniques*, Wiley & Sons Inc.
5 Skoog, D.A., Holler, F.L. and Crouch, S.R. (2007) *Principles of instrumental analysis*, Thomson Brooks/Cole Publishers.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations, E-tutoring & E- learning, case study, cooperative learning, problem solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/DSC2

MSc/EES/2/DSC2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	-	3	3	3	3
CO2	2	-	-	-	2	-	3	3
CO3	2	-	-	-	2	-	3	3
CO4	2	-	-	-	2	-	3	3
Average	2	2	2	-	2.25	3	3	3

CO-PSO MAPPING for MSc/EES/2/DSC2

MSc/EES/2/DSC2	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3
CO2	2	2	2	3
CO3	1	1	3	3
CO4	3	2	3	3
Average	2.25	1.75	2.5	3

COURSE CODE: MSc/EES/2/DSC3 (A)
COURSE TITLE: BIOSTATISTICS AND COMPUTER APPLICATIONS

Credit: 4 **Marks: 100**
Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The aim of the course is to develops skills on various operating systems, application software, statistical tool and technique and their utility in the field of environmental research and industrial organizations.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To describe the basics of computer, different types of operating system and various application software used in the field of environmental sciences.

CO2: To collect, manage and represent the data via different types of tables and graphs.

CO3: To enlighten various descriptive and inferential statistical tools and technique and their utility in research.

CO4: To explain various statistical tool and techniques and their application in environmental data analysis.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Basic concepts of computer; History of computer evolution; Computer hardware; Operating systems: windows, unix and linux; Use of common application software in biology: word processing, spreadsheets, graphics and data base; Introduction to web browsing software and search engines with special reference to online environmental resources.

UNIT II **15 Hours**

Concept of sample and population; Sampling; Sampling techniques: Random and Non-random; Qualitative and quantitative data; Discrete and continuous data; Scales of measurement: nominal, ordinal, ratio, interval; Collection and scrutiny of data; Data representation: line chart, bar chart, pie chart, histogram, frequency polygon, frequency curve, ogive curve; Measures of central tendency: mean, median, mode, geometric mean, harmonic mean.

UNIT III **15 Hours**

Absolute and relative measures of dispersion: range, quartile deviation, mean deviation, standard deviation, variance, coefficients of dispersion; Concept of moment; Skewness and Kurtosis; Correlation: scatter diagram, principle of least squares, karlpearson's correlation coefficient, coefficient of determination; Linear regression: simple linear regression;

UNIT IV **15 Hours**

Basic concept of probability theory; Basic concept of distributions: normal, lognormal, binomial, poisson; Testing of hypothesis and its significance; "t" test; Chi-square test: goodness of-fit, test of independence, test of homogeneity; ANOVA: one way.

Suggested readings:

1. Weiss, N.A. (2012) *Elementary statistics*, Pearson.

2. Manly, B.F.J (2008) *Statistics for Environmental Science & Management*, CRC Press.
3. Kapoor, V.K. and Sanchite, D.C. (2017) *Statistics-Theory, Methods and Application*, Sultan Chand & Sons.
4. Schuenemeyer, J.H. and L.J. (2010) *Statistics for Earth and Environmental Science*, Wiley & Sons Inc.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/DSC3 (A)

MSc/EES/2/DSC3 (A)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	1	1	-	-	1	2
CO2	2	1	1	1	1	2	3	3
CO3	2	1	2	1	1	2	3	3
CO4	2	1	1	1	1	2	3	3
Average	2.25	1.25	1.25	1	1	2	2.5	2.75

CO-PSO MAPPING for MSc/EES/2/DSC3 (A)

MSc/EES/2/DSC3 (A)	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	3
CO2	2	3	3	3
CO3	2	3	3	3
CO4	1	3	3	3
Average	1.5	2.5	2.75	3

COURSE CODE: MSc/EES/2/DSC3 (B)

COURSE TITLE: ACADEMIC INTEGRITY, ETHICS & BIOSAFETY

Credit: 4 **Marks: 100**
Exam. Duration:3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of this course is to introduces the student about the basics of Intellectual Property Rights, Copy Right Laws Trade Marks and Issues related to Patents along with biosafety for dealing with biological risk and hazards too.

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: Academic Integrity, Plagiarism (prevention and detection) and UGC regulations
CO2: Research and Publications ethics and best practices.
CO3: To acquire the knowledge and understanding of patent search and documentation of research activities that would aid an IPR expert to draft, apply and prosecute IPR applications.
CO4: Gain knowledge about basics of biosafety, GM technology and recognize importance of biosafety practices and guidelines in research

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

Unit I **13 Hours**

Introduction to Academic Integrity; Academic Integrity Values; Honesty and Trust; Fairness and Respect; Responsibility and Courage; Violations of Academic Integrity-types and consequences; Plagiarism, Plagiarism arising out of misrepresentation-contract cheating; collusion; copying and pasting; recycling; Avoiding Plagiarism through referencing and writing skills; UGC Policy for Academic Integrity and prevention; Some Plagiarism detection tools

Unit II **15 Hours**

Research and Publication ethics: Scientific misconducts- Falsifications, Fabrication and Plagiarism (FPP); Publication ethics- definition; introduction and importance;best practices/standard setting initiatives and guidelines-COPE; WAME etc.; Violation of publication ethics; authorship and contributor-ship; misconduct; complains and appeals; Conflicts of Interest; Predatory publisher and journals.

Unit III **15 Hours**

Introduction to Intellectual Property; Basics of Patents and Types; Concept of Prior Art Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Patent filing; Forms and fees Invention in context of “prior art”; Patent databases; Searching National and International Databases.

Unit IV **17 Hours**

Introduction to Biological Safety Cabinets; Primary containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release

of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

Suggested readings:

1. MacIntyre, A. (2002) *A short History of Ethics*, Routledge.
1. Chaddah, P. (2018) *Ethics in Competitive Research: Do not get scooped; do not get plagiarized*, Pothi.
2. Beall, J. (2012) *Predatory publishers are corrupting open access*, Nature.
3. Muralidhar, K., Ghosh, A., and Singhvi, A.K. (2019) *Ethics in Science Education, Research and Governance*, Indian National Science Academy.
4. Narayanan, P. (2015) *Intellectual Property Laws*, Eastern Law House.
5. Paul, M. (2014) Intellectual Property Laws, Allahabad Law Agency.
6. Ahuja, V.K. (2007)*Law Relating to Intellectual Property Rights*, Lexis Nexis Butterworths.
7. Bouchoux, D.E. (2012) *Intellectual Property Rights*, Cengage Learing.
8. Wooley, D.P and Byer, K.B. (2017) *Biological Safety: Principles and Practices*, Wiley & Sons Inc.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/2/DSC3 (B)

MSc/EES/2/DSC3 (B)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	3	3
CO3	-	-	-	-	-	3	3	3
CO4	1	2	3	3	2	1	1	1
Average	1	2	3	3	2	2.33	2.33	2.33

CO-PSO MAPPING for MSc/EES/2/DSC3 (B)

MSc/EES/2/DSC3 (B)	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	3
CO2	1	1	1	3
CO3	1	2	1	3
CO4	2	2	2	2
Average	1.25	1.5	1.25	2.75

COURSE CODE: MSc/EES/2/SEC2
COURSE TITLE: LAB III- ENVIRONMENTAL MONITORING: WATER

Credit: 4 **Marks: 100**
Practical Hrs: 4 + 4 **Exam duration: 6 hrs**

COURSE OUTCOMES:
After completion of the course, the student will be

CO1: Able to characterize water quality parameters and get knowledge about water quality standards for consumption of living beings.
CO2: Able to design various experiments for analyzing the water pollutants.
CO3: Able to apply analytical tools, technique to determine and measure water quality parameter.
CO4: Able to operate instruments like pH meter, EC meter, DO meter, UV- Visible spectrophotometer, flame photometer etc.

1. Determination of pH in a given water sample.
2. Determination of various form of alkalinity in a given water sample
3. Determination of Total hardness, calcium and magnesium hardness in a given water sample.
4. Determination of Total solids, suspended solid and dissolved solids in a given water sample.
5. Determination of conductivity in a given water sample.
6. Determination of Turbidity in a given water sample.
7. Determination of DO in given water sample.
8. Determination of BOD 5 day and ultimate BOD in sewage sample.
9. Determination of COD by open and closed reflux method in given waste water sample.
10. Determination of mineral contents in a given water sample (Calcium, Sodium, Potassium, Fluoride, Chloride, Phosphate and Sulphate).

CO-PO MAPPING for MSc/EES/2/SEC2

MSc/EES/2/SEC2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	2	-	-	2	-	-
CO2	2	2	1	2	-	1	-	1
CO3	2	1	1	1	-	1	-	2
CO4	2	2	2	2	1	2	-	1
Average	1.75	1.75	1.5	1.66	1	1.50	-	1.33

CO-PSO MAPPING for MSc/EES/2/SEC2

MSc/EES/2/SEC2	PSO1	PSO2	PSO3	PSO4
CO1	1	3	-	-
CO2	2	3	-	2
CO3	2	-	-	1
CO4	1.75	1	2	2
Average	2	2.33	2	1.66

COURSE CODE: MSc/EES/2/CC8
COURSE TITLE:Lab IV - ENVIRONMENTAL MONITORING: AIR & NOISE

Credit: 4 **Marks: 100**
Practical Hrs:4 + 4 **Exam duration: 6 hrs**

Course Objectives: This course envisagesto develop the analytical skills of the students for handling instruments for quantitative analysis of air and noise in the environment.

Course Outcomes: After completion of this course, the students will be able to:

CO1: Design various experiments for sampling and analysing air pollutants
CO2: Learn about the techniques of gaseous and particulate sampling of ambient environment
CO3: Lear about the instruments used in air pollutant analysis
CO4: Demonstrate key practical skills in working with environmental noise

1. Air Sampling
2. Determination of Suspended particulate matter using high volume sampler in Residential area.
3. Determination of Suspended particulate matter using high volume sampler in Institutional area.
4. Determination of SO_x in ambient air.
5. Determination NO_x in ambient air.
6. Estimation of Atmospheric Dust fall.
7. Estimation of Noise in Residential area.
8. Estimation of Noise in Institutional area.

CO-PO MAPPING for MSc/EES/2/CC8

MSc/EES/2/CC8	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	1	-	2	1	3	3
CO2	2	-	2	-	1	-	3	3
CO3	2	-	2	-	1	-	3	3
CO4	2	2	2	-	2	-	3	3
Average	2	1.5	1.75	-	1.5	1	3	3

CO-PSO MAPPING for MSc/EES/2/CC8

MSc/EES/2/CC8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3
CO2	3	2	3	3
CO3	3	2	3	3
CO4	3	2	3	3
Average	3	2	3	3

COURSE CODE: MSc/EES/3/CC9
COURSE TITLE: ENVIRONMENTAL MICROBIOLOGY

Credit: 4 **Marks: 100**
Exam. Duration: 3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to acquaint the student about the concepts of microbes, microbiology and strategies for restoration of air, water and soil.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To learn about the microbial world and basic features of microorganisms, their interaction with various environmental components.

CO2: To learn about the nature of air microflora, their transmission and control.

CO3: To learn about the nature of water microflora, their qualitative and quantitative estimation

CO4: To learn about the nature of soil microflora, and also to understand the principle and applications of microorganisms for environmental restoration.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Microbial world: Introduction of environmental microbiology, relation of environmental microbiology with other allied sciences, Major groups of micro-organisms, Microbial interactions- neutralism, commensalism, synergism, mutualism, competition, ammensalism, parasitism, predation; interaction of microorganisms with plant and animals.

UNIT II **15 Hours**

Air microbiology: Microflora of air- Outdoor and indoor microflora, Transmission of Microflora in air, enumeration and assessment of microorganisms in air, sources of contaminations of air: Outdoor and indoor, control mechanism of airborne microorganisms.

UNIT III **15 Hours**

Water microbiology: Microbes in aquatic system, pathogens in water, Biofilms, bacteriological analysis of water and tests for indicator organisms, standard plate count method (SPC), most probable number count method (MPN), membrane filter method (MF), Role of microbes in wastewater treatment.

UNIT IV **15 Hours**

Soil microbiology: distribution of different types of soil microorganisms, factors influencing microbial population, Rhizosphere effect, microbes in decomposition, mineralization and recycling process, Bioremediation, Solubilization of phosphate (PSB).

Suggested reading:

1. Black, J.G. (2014) *Microbiology: Principles and Explorations*, Wiley & Sons Inc.
2. Agrawal, K.C. (2011) *Environmental and applied Microbiology*, Nidhi Publishers.
3. Pelzar (1998) *Microbiology*, McGraw-Hill Education.
4. Glazer, A.N. (2007) *Microbial Botechnology: Fundamentals of Applied Microbiology*, Cambridge University Press.
5. Atlas, R.M. and Bartha, R. (1981) *Microbial Ecology: Fundamentals and Applications*, Benjamin / Cummings Publication Company.
6. Parija, S.C. (2012) *Textbook of Microbiology and Immunology*, Elsevier.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/3/CC9

MSc/EES/3/CC9	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	1	2	2	-	-	2
CO2	3	3	2	2	1	2	3	2
CO3	3	-	2	1	1	2	3	3
CO4	3	1	2	2	2	-	-	2
Average	3	2.33	1.75	1.75	1.5	2	3	2.25

CO-PSO MAPPING for MSc/EES/3/CC9

MSc/EES/3/CC9	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	2
CO2	3	3	3	2
CO3	3	2	3	3
CO4	3	2	-	2
Average	3	2.5	3	2.25

COURSE CODE: MSc/EES/3/CC10

COURSE TITLE:POLLUTION CONTROL & MANAGEMENT

Credit: 4 **Marks: 100**

Exam.Duration: 3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The purpose of this course is to impart knowledge about the essential principles of water, air and noise pollution control and management of waste generated from different sectors in a manner to meet public health and environmental concerns. The students will learn how to advance the scientific, technical and practical aspects of pollution control and waste management.

COURSE OUTCOMES:

On successful completion of this course, the students will be able to:

CO1:Gain the knowledge about various stages involved in treatment of water and wastewater.

CO2: Understand principle, theory, working and practical applications of various equipments used for control of gaseous and particulate air pollutants.

CO3: Develop understanding of types, characterization, impacts and management of municipal waste, biomedical waste, Hazardous waste, e- waste and other wastes and will be able to appreciate the importance of waste reduction, reuse and recycling.

CO4: Obtain knowledge about Noise pollution control methods.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Waste water treatment: Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening.Primary treatment methods-screening, grit removal, primary sedimentation; Secondary treatment methods-activated sludge process, trickling filters, rotating biological contactors, oxidation ponds and lagoons, Advanced waste water treatment methods-removal of nutrients and solids; waste water reuse and sludge treatment and disposal.

UNIT II **15 Hours**

Air pollution control: Control methods for particulates-gravitational settling chambers, centrifugal collectors, wet collectors/scrubbers, fabric filters, electrostatic precipitators, Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion.

UNIT III **15Hours**

Waste management: Types and sources of Municipal Solid waste, Characterization (Physical and Chemical), Collection, Transportation, Handling, Treatment, Disposal and Recycling of solid waste, composting, vermicomposting, incineration and Sanitary landfills; Hospital waste management; e-waste: classification, methods of handling and disposal.

UNIT IV **15 Hours**

Hazardous waste management and Noise pollution control: Hazardous waste – Definition, sources and categorization, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. Noise pollution control: Absorbing materials, barrier materials, damping materials, Active noise control methods.

Suggested Readings

1. Rao, C.S. (2006) *Environmental Pollution Control Engineering*, New Age International (P) Limited.
2. Kulkarni, V. and Ramchandra, T.V. (2006) *Management of Municipal Solid waste*, TERI Press.
3. Hosetti, B.B. (2006) *Prospects and Perspectives of Solid Waste Management*, New Age International Ltd.
4. Rao, M.N. and Rao, H.V.N. (2018) *Air pollution*, McGraw Hill Education.
5. Cooper C.D. and Alley F.C. (2014) *Air pollution control: A design approach*, Medtech.
6. Mudakavi, J.R. (2010) *Principle and practices of air pollution control and analysis*, I.K. International Publishing House.
7. Peavy,H.S., Rowe, D.R. and Tchobanoglous, G. (1985) *Environmental Engineering*, McGraw Hill.
8. Masters, G.M. and Ela W.P. (2013) *Introduction to Environmental Engineering and Science*, Pearson.
9. Bell, L.H. and Bell, D.H. (1994) *Industrial Noise Control: Fundamentals and Applications*, CRC Press.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations, E-tutoring & E- learning, case study, cooperative learning, problem solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/3/CC10

MSc/EES/3/CC10	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	2	1	2	1	3
CO2	1	-	2	-	1	3	2	3
CO3	2	-	2	-	1	3	2	2
CO4	-	1	2	-	2	3	1	1
Average	1.66	1.5	2.0	2	1.25	2.75	1.5	2.25

CO-PSO MAPPING for MSc/EES/3/CC10

MSc/EES/3/CC10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3
CO2	3	3	2	3
CO3	1	2	2	3
CO4	-	2	2	3
Average	2.33	2.25	2.25	3.0

COURSE CODE: MSc/EES/3/CC11
COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY

Credit: 4 **Marks: 100**
Exam. Duration: 3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to acquaint the students about the basic concepts and application of Biotechnology in Environmental monitoring and Environmental management, Concept, significance and strategies of Sustainable agriculture, significance of agriculture in Indian economy and role of Indian council of agricultural research

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: have better understanding of Biotechnology and its applications in environmental monitoring.

CO2: have better understanding of organism mediated strategies and methods in environmental management of different ecosystems.

CO3: know the concept of sustainable agriculture and application of microorganism mediated strategies and methods in practice of sustainable agriculture.

CO4: know the role of agriculture in Indian economy, Indian council of agricultural research and its mandate on agricultural diversity. Strategies of forest management and afforestation programmes

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **14 Hours**

An Introduction to Environmental biotechnology, Fundamentals of Environmental biotechnology. Concept of Genetic Engineering, Recombinant-DNA Technology, Genetically Modified Organism, Bt Cotton, Concept of Biosensor, types and its applications in environmental monitoring.

UNIT II **15 Hours**

Application of biotechnology in environmental management, Bioremediation, Phytoremediation, Biotechnological approaches for preserving biodiversity: Gene banks, Germplasm bank, Microbial culture banks.

UNIT III **15 Hours**

Green revolution, Environmental Issues related to agrochemicals, Concept of Sustainable Agriculture, Organic farming and its Ecological significance, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Allelopathy, Biofertilizer, Biopesticide, Fermentation Technology, Composting, Vermicomposting.

UNIT IV **15 Hours**

Significance of Agriculture in Indian Economy, Role of Indian Council of Agriculture Research (I.C.A.R.), Concept of Crop rotation, Silviculture, Agro-forestry, Social Forestry, Joint Forest Management (JFM).

Suggested readings

1. Mohapatra, P.K. (2006) *Text book of Environmental Biotechnology*, I K International Publishing House.
2. Chatterji, A.K. (2011) *An Introduction to Environmental Biotechnology*, PHI Publishing House.

3. Dhawan, V. (2008) *Agriculture for food security and rural growth*, TERI.
4. Singh, N. and Tripathi. R.D. (2008) *Environmental bioremediation Technologies*, Springer.
5. Nair, P.K.R and Garrity, D. (2012) *Agroforestry- The Future of global land Use*, Springer.
6. Saxena, S. (2015) *Applied Microbiology*, Springer.
7. Singh, R.L. (2017) *Principles and applications of environmental biotechnology for a sustainable future*. Springer.
8. Panpatte, D.G., Jhala, Y.K., Vyas, R.V. and Shelat, H.N. (2017) Micro-organisms for green revolution. Springer.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/3/CC11

MSc/EES/3/CC11	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	3	2	2	--	2
CO2	2	2	3	2	2	2	--	2
CO3	3	2	3	3	2	3	--	3
CO4	2	2	3	2	2	2	1	2
Average	2.25	1.75	1.75	2.25	2	2.25	1	2.25

CO-PSO MAPPING for MSc/EES/3/CC11

MSc/EES/3/CC11	PSO1	PSO2	PSO3	PSO4
CO1	2	--	1	3
CO2	2	2	1	3
CO3	2	2	2	3
CO4	2	2	2	2
Average	2	1.5	1.5	2.75

COURSE CODE: MSc/EES/3/CC12

COURSE TITLE: ENVIRONMENTAL LAW

Credit: 4 **Marks: 100**

Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The aim of this course is to developed understanding for various environment policies, planning and legal aspects for environmental conservation and protection in India.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To develop understanding regarding ancients and constitutional aspect of environmental protection and judicial response to various environmental issues in India.

CO2: To explain various environmental legislations for the protection of wildlife and forest in India.

CO3: To understand legal issues and legislative provisions for the protection of natural resources.

CO4: To critically analyse legal aspect of different types of waste managements in India.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

India's Ancient Traditions for Protection of Environment; Constitutional Provisions for Protection of Environment; National conservation strategy and Policy statement on Environment and Development 1992; Environmental Impact Assessment Notification 1994 and amendment; National Green Tribunal Act 2010 and amendment; Green Bench; Ecomark scheme.

UNIT II **15 Hours**

Wildlife Protection Act, 1972 and amendment; Indian Forest Act, 1982 and amendment; Forest Conservation Act, 1980 and amendment; Indian Forest act, 1982 and amendment; National Forest Policy, 1988 and amendment; Biodiversity Conservation Act, 2002 and amendment.

UNIT III **15 Hours**

The Water (prevention and Control of Pollution) Act, 1974 and amendment; The Air (prevention and Control of Pollution) Act, 1981 and amendment; Ozone depleting Substances Regulation and Control rules 2000 and amendment; Environmental Protection Act, 1986 and amendment; Noise Pollution Regulation and Control Rules, 2000 and amendment; Environmental Audit Notification 1992 and amendment;

UNIT IV **15 Hours**

Biomedical Waste Management and Handling Rules, 2016; Hazardous Waste Management and Handling rules, 2016; Solid Wastes (Management and Handling) Rules, 2016; Plastics waste management rules, 2016; Energy Act 2002 and amendment; Public Liability Insurance Act, 1991 and amendment; Disaster Management Act 2005 and amendment; Fly ash notification, 2019.

Suggested readings:

1. Malik, S. (2013) *Environmental Law*, Eastern Book Company.
2. Shastri, S.C. (2018) *Environmental Law*, Eastern Book Company.
3. Tiwari, A.K. (2006) *Environmental Laws in India*, Deep and Deep Publications.
4. Divan, S. and Rosencranz, A. (2020) *Environmental Law and Policy in India*, Oxford University Press.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/3/CC12

MSc/EES/3/CC12	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	1	-	-	-	1	-	1
CO2	-	1	2	-	-	1	-	2
CO3	--	1	2	-	-	1	-	2
CO4	-	1	1	-	-	1	--	2
Average	-	1	1.66	-	-	1	-	1.75

CO-PSO MAPPING for MSc/EES/3/CC12

MSc/EES/3/CC12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1	1
CO2	2	-	3	2
CO3	3	2	3	2
CO4	2	2	3	2
Average	2.33	2	2.5	1.75

COURSE CODE: MSc/EES/3/SEC3 (A)

COURSE TITLE: LAB V- ENVIRONMENTAL MICROBIOLOGY

Credit: 4 **Marks: 100**

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: Prepare different growth media for cultivation of diverse microorganisms

CO2: Isolate different microorganism from different spheres of the environment

CO3: Grow the isolated microorganism in both solid and liquid media for growth related studies

CO4: Prepare slides for microscope-based studies

1. Concept and preparation of different culture media.
2. Isolation of fungi from soil sample.
3. Isolation of bacteria from soil sample.
4. Isolation of fungi from water and waste water samples
5. Isolation of bacteria from water and waste water samples.
6. Slide preparation of fungal and bacterial samples for microscopic studies.
7. Gram staining of bacterial isolates
8. Estimation of fungal biomass in liquid media
9. Estimation of bacterial biomass in liquid media
10. Calculation of Fungal colony by Colony Forming Units (CFU).

CO-PO MAPPING for MSc/EES/3/SEC3 (A)

MSc/EES/3/SEC3 (A)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	1	2	1	2	3
CO2	2	2	1	1	2	1	2	2
CO3	2	2	1	1	2	2	2	3
CO4	2	2	1	1	2	2	--	3
Average	2	2	1.25	1	2	1.5	2	2.75

CO-PSO MAPPING for MSc/EES/3/SEC3 (A)

MSc/EES/3/SEC3 (A)	PSO1	PSO2	PSO3	PSO4
CO1	1	1	3	2
CO2	3	2	3	2
CO3	2	2	3	2
CO4	--	2	3	2
Average	2	1.75	3	2

COURSE CODE: MSc/EES/3/SEC3 (B)

COURSE TITLE LAB V: SOLID WASTE

Credit: 4 **Marks:100**
Practical Hrs: 4 + 4 **Exam duration: 6 hrs**

COURSE OUTCOMES:
After completion of the course, the student will be able
CO1: Understand the characteristics and composition of Solid waste in Rural and Urban settlements.
CO2: To acquire practical knowledge of waste management.
CO3: To understand practical aspects of various physio-chemical characteristics of solid waste.
CO4: To acquire the skill of onsite management of solid waste.

1. Characterization of Solid Waste
2. Composition of Solid waste in Rural settlement
3. Composition of Solid waste in Urban settlement
4. Estimation of Bulk Density of solid waste
5. Estimation of Moisture Content of Solid waste
6. Estimation of Volume of Solid waste

CO-PO MAPPING for MSc/EES/3/SEC3 (B)

MSc/EES/3/SEC3 (B)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	3	2	1	3
CO2	-	-	1	-	2	1	3	3
CO3	2	-	1	-	2	1	3	3
CO4	2	--	1	--	2	1	3	3
Average	2	1	1	-	1.75	1	2.50	3

CO-PSO MAPPING for MSc/EES/3/SEC3 (B)

MSc/EES/3/SEC3 (B)	PSO1	PSO2	PSO3	PSO4
CO1	1	3	2	3
CO2	-	-	3	3
CO3	1	3	3	3
CO4	1	1	3	2
Average	1	2.33	2.75	2.75

COURSE CODE: MSc/EES/3/SEC3 (C)

COURSE TITLE: LAB V: PRACTICAL ASPECTS OF ENERGY

Credit: 4 **Marks:100**
Practical Hrs:4 + 4 **Exam duration: 6 hrs**

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To apply analytical tools to determine and measure calorific value of various types of fuels.
CO2: To understand the principle and working of solar appliances.
CO3: To understand the principle and working of solar bio-based fuels.
CO4: To get familiarize with various Energy harvesting system through field visit.

1. To determine the Calorific value of given materials.
2. To understand the principle and working of solar power panel.
3. To understand the principle and working of solar cooker.
4. To understand the principle and working of solar heater.
5. To determine the total shining hours using sunshine recorder.
6. To understand the principle and working of biogas plant.
7. To understand the principle and working of solar pond.

CO-PO MAPPING for MSc/EES/3/SEC3 (C)

MSc/EES/3/SEC3 (C)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	-	1	1	2	-
CO2	2	2	3	1	2	-	1	1
CO3	2	2	3	1	1	-	1	2
CO4	2	2	2	-	2	1	2	2
Average	2	2	2.5	1	1.5	1	1.5	1.66

CO-PSO MAPPING for MSc/EES/3/SEC3 (C)

MSc/EES/3/SEC3 (C)	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	3	3
CO3	2	2	3	3
CO4	2	1	2	3
Average	3	3	2.5	3

COURSE CODE: MSc/EES/4/CC13
COURSE TITLE: ENERGY RESOURCES

Credit : 4 **Marks: 100**
Exam. Duration: 3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to make the student to understand about different energy forms, importance of renewable and non-renewable energy sources and its consumption pattern in the world and India. It also enables students to learn about principle, generation and applications of different forms of energy and their respective managerial aspects.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To learn about the different ways to classify energy resources, their consumption pattern and their respective environmental significance.

CO2: To know the various features of non-renewable energy sources prevailing in the environment.

CO3: To learn to apply various technologies for generation of renewable energy from different environmental sources.

CO4: To apply learnt methods for energy conservation and energy management at home and organization.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Energy sources- renewable & non-renewable, conventional & non-conventional, primary, secondary & substantial energy sources; Energy consumption pattern in India, Rural Energy consumption pattern in India; conservation strategy of energy resources, environmental impacts of energy resources.

UNIT II **15 Hours**

Non-renewable Energy: Fossil fuel -Coal, Petroleum, Natural gas; Classification, composition and characterization of Coal, Petroleum, Natural gas; energy content and calorific value of Coal, Petroleum, Natural gas, other energy sources- shale oil, coal bed methane, gas hydrates.

UNIT III **15 Hours**

Renewable energy; Sun as a source of energy - Solar energy, solar radiation and its spectral characteristics, Solar radiation measurement, solar collectors, Photo-Voltaic modules, Solar pond; Nuclear energy, Different Type of nuclear reactors and their significance.

UNIT IV **15 Hours**

Energy conversion technologies: Principles of generation of Wind energy, Geothermal energy, Ocean energy: Tidal energy and wave energy, Ocean Thermal Energy Conversion (OTEC), solar energy, Bioenergy, Biomass conversion Technologies, Biogas, Producer gas, Energy Plantations/Petro-crops.

Suggested readings:

1. Abbi, Y. and Jain, S. (2015) *Handbook on Energy and Environment management*, TERI.
2. Zobana, A.F. and Bansal, R.C. (2011) *Handbook of Renewable Energy Technology*, World Scientific Publishing Company.
3. Sørensen, B. (2017) *Renewable Energy- Physics, Engineering, Environmental Impacts, Economics and Planning*, Elsevier.
4. Carpareda, S.C. (2013) *Introduction to biomass Energy Conversions*, CRC press.
5. Sukhatme, S.P. (2000) *Solar Energy-Principles of Thermal Collection and Storage*, Tata McGraw Hill.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/4/CC13

MSc/EES/4/CC13	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	-	1	1	2	-
CO2	2	2	3	1	2	-	1	1
CO3	1	2	3	1	1	-	1	2
CO4	2	2	2	-	2	1	2	2
Average	2	2	2.5	1	1	1	1.5	1.66

CO-PSO MAPPING for MSc/EES/4/CC13

MSc/EES/4/CC13	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-
CO2	3	3	3	3
CO3	2	2	3	3
CO4	2	1	2	-
Average	3	3	2.5	3

COURSE CODE: MSc/EES/4/CC14

COURSE TITLE: ENVIRONMENTAL HEALTH AND TOXICOLOGY

Credit: 4 **Marks: 100**

Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

The objective of the curriculum is to acquaint the students about the Occupational hazards, Xenobiotic compoundsas pollutants and disease-causing microbial agents affecting human health.

COURSE OUTCOMES:

After completion of the course, the student will be able to

CO1: know the principles of toxicology, different toxicants causing health hazards and will have the thorough understanding of entry and detoxification mechanisms of xenobiotic compounds in human body

CO2: to know the occupational health hazards associated with different occupations and occurrence of industrial disasters.

CO3: understand the epidemiological diseases affecting human health and role of trace elements in human body

CO4: to know the concept of Radiation Pollution and its effect on different organisms representing different ecosystems.They also able to explain various types of chemical and biochemical hazards and disasters and efforts at national and international level to combat them.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **16 Hours**

Introduction and Principles of Toxicology, Toxic chemicals in the environment and their effects, Xenobiotic Compounds, Toxic responses of xenobiotic compounds in animal and plant system, Pesticide: classes and types, Toxic effects of DDT, Endosulphan, 2. 4 D on humans. Mode of entry of Toxic substances in human body and Detoxification sites in human body, Bioaccumulation, Biotransformation. Toxic effects of heavy metals : Lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg).

UNIT II **14 Hours**

Occupational Health Hazards, Major occupational Diseases, protective and safety measures for occupational health hazards, International and National organizations in the field of occupational health, Industrial disasters: Bhopal gas tagedy.

UNIT III **14 Hours**

Epidemiological Issues- Goiter, Fluorosis and Arsenic poisoning. Concept and significance of trace elements, deficiency and disorder related to trace elements. Water borne diseases and Food borne diseases. Malaria: Life cycle of *Plasmodium* species, Tuberculosis and AIDS.

UNIT IV **15 Hours**

Radioactive pollution issues and causes with disaster radiation: Natural and anthropogenic sources of radiation in Environment, Concept of Radioactivity, Radioactive waste. Effect of Radioactive pollution on Plants,

Animals and Humans, Chernobyl disaster, Outbreak of epidemic and pandemic diseases, Biological warfare, Biological terrorism, Bhopal gas Tragedy, Exxon Valdez Oil spill.

Suggested readings

1. Pani, B. (2010) *Text book of Toxicology*, I K International Publishing House.
2. Sharma, B.K. (2008) *Nuclear and Radiation Chemistry*, Goel Publishing House.
3. Landis, W.G., Sofield, R.M. and Ming, H. (2011) *An Introduction to Environmental Toxicology*, CRC press.
4. Klaassen, C. (2019) *Toxicology: The basic science of poisons*, Mc Graw Hill education.
5. Keller, E.A. (2012) *Introduction to Environmental Geology*, Pearson.
6. Rohli, R.V. and Vega, A.J. (2018) *Climatology*, Jones and Bartlett Learning.
7. Hyndman, D. and Hyndman, D. (2016) *Natural Hazards and Disasters*, Brooks/Cole.
8. Singh, J. (2008) *Disaster management*, APH Publishing Corporation.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

.

CO-PO MAPPING forMSc/EES/4/CC14

MSc/EES/4/CC14	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	--	1	2	2	1	2
CO2	2	1	--	1	1	2	1	2
CO3	2	2	2	--	1	2	1	2
CO4	1	1	1	--	2	2	1	2
Average	1.75	1.25	1.5	1.	1.25	2	1	2

CO-PSO MAPPING for MSc/EES/4/CC14

MSc/EES/4/CC14	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	3
CO2	1	3	1	3
CO3	1	2	2	2
CO4	1	3	1	1
Average	1	2.75	1.25	1.75

COURSE CODE: MSc/EES/4/CC15
COURSE TITLE: REMOTE SENSING AND MODELLING

Credit: 4 **Marks: 100**

Exam duration: 3Hrs **Theory +Internal assessment: 70+30**

Course Objectives: The objective of the course is to provide knowledge of principles of different aspects of geospatial technology, viz. Remote Sensing (RS), Geographic Information Systems (GIS) and Global Positioning System (GPS) and the application of these techniques to the various domains of environmental science. Students will also acquire knowledge on types of models, procedure followed in model development, and applications of models in research and industrial organizations. The technical skills obtained from this course will prepare the students for national and global employability in field of RS, GIS and Modelling.

Course Outcomes: On successful completion of this course, the students will be able to:

CO1. Build a foundation of Remote Sensing (RS), Geographic Information System (GIS) and global positioning system (GPS) as tools, their scope and usage for monitoring and analyzing the changes in earth and its environment.

CO2. Build an understating of types, process, platforms and sensors used in RS with an emphasis on optical and microwave remote sensing.

CO3. Build an understating about the elements and techniques of visual image interpretation, concepts and techniques of image processing and photogrammetry.

CO4. Acquire knowledge about types of models, procedure followed in model development; scope, applications and limitations of models in environmental research and management.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Basic concepts and principals of remote sensing, Sensors and platforms, Physical Basis of remote sensing, Photo interpretation, Digital image processing and ground truthing, Geographical Information System (GIS) and Global Positioning System (GPS).

UNIT II **15 Hours**

Application of remote sensing and GIS in: Environmental management, Forestry, Land cover / Landuse planning, Natural disasters, Vegetation studies, Natural resources, Climate Change, Urban Sprawling.

UNIT III **15 Hours**

Role of modelling in environmental sciences, Model classification: Deterministic model, Stochastic model, Steady state model, Dynamic model, Different stages involved in model building. Methods for the formulation of dynamic balance equation- Mass balance procedures, Energy balance procedures.

UNIT IV **15 Hours**

Streeter Phelps Oxygen Sag model, Box model, Gaussian Plume model, Two Species population growth model of competition, Lotka-Volterra Prey predator model, Logistic Growth Curve, Maximum sustainable yield, Carrying capacity, Leslie's matrix model.

Suggested Readings:

1. Joseph, G. and Jeganathan, C. (2018) *Fundamentals of Remote Sensing*, Universities Press.
2. Jensen, J.R. (2017) *Remote sensing of the environment: An earth resource perspective*, Pearson.
3. Lillesand, T.M., Kiefer, R.W. and Chipman J.W. (2016) *Remote Sensing and Image Interpretation*, Wiley & Sons Inc.
4. Snape, J.B., Dunn, I.J., Ingham, J. and Prenosil J.E. (1995) *Dynamics of Environmental Bioprocesses-Modeling and Simulation*, VCH.
5. Barrett, E.C. and Curtis L.F. (1999) *Introduction to Environmental Remote Sensing*, Routledge.

Teaching-Learning Process

- **Lectures:** Supported by black board teaching, power point presentations, related videos and demonstrations, E-tutoring & E- learning, case study, cooperative learning, problem solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/4/CC15

MSc/EES/4/CC15	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	-	2	2	2	2
CO2	2	-	-	-	2	2	2	2
CO3	2	-	2	-	-	2	2	2
CO4	2	2	2	-	1	2	3	3
Average	2.0	2.0	2.0	-	1.66	2.0	2.25	2.25

CO-PSO MAPPING for MSc/EES/4/CC15

MSc/EES/4/CC15	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	3
CO2	-	-	2	3
CO3	2	-	2	3
CO4	3	3	2	-
Average	1.75	2	2.25	3

COURSE CODE: MSc/EES/4/CC16

COURSE TITLE: NATURAL RESOURCES MANAGEMENT

Credit: 4 **Marks: 100**

Exam. Duration: 3Hrs **Theory+Internal assessment: 70+30**

COURSE OBJECTIVES:

The course provides students a comprehensive review of our natural resources including land, water, energy, mineral, forest, range land, and marine resources and also economically sustainable forest management designs. The students will be able to understand the importance of natural resource management and the mechanisms for environment protection.

COURSE OUTCOMES:

On successful completion of this course, the students will be able to:

CO1: Understand types, issues and conservation of natural resources

CO2: Become familiar with various biological resources and importance and management.

CO3: Develop understanding about water resources, and management techniques.

CO4: Acquire knowledge about land resources, soil related issues and their management and become familiar with mineral resources and their conservation strategies

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **12 Hours**

Natural Resource: Definition, Principle of natural resource conservation, types of natural resources, major issues related to natural resources management.

UNIT II **15 Hours**

Biological Resources: Forest types in India theirimportance and management, Range lands and their importance and management,Wetland importance and its management, Floral and Faunal resources of the World and India, Botanical Survey of India, Forest Survey of India, Zoological Survey of India, Plants of medicinal importance, Ethno botanical importance, De-forestation and desertification and their impact on Wildlife Management.

UNIT III **14 Hours**

Water Resources: Water resources types, Surface water: Rivers, Lakes etc, Underground water and aquifers, Current scenario of water related issues,management of watersheds, Rehabilitation of Eutrophicated lakes, rehabilitation of polluted rivers- Ganga action plan, Yamuna action plan; rain water harvesting.

UNIT IV **15 Hours**

Land Resources: Major Soil types of India, Mineral resources and reserves, Ocean ores and recycling of resources, Processing and smelting of mineral, Oceans as need areas for exploitation of mineral resources,wasteland management, Reclamation of usar, alkaline and saline soil.

Suggested readings:

1. Cunningham, W.P. and Cunningham, M.A. (2002*) Environmental Science: Inquiry and Applications. A Global Concern,* Tata McGraw-Hill Publishing.

2. Chape, S., Fish, L., Fox, P. and Spalding, M. (2003) *United Nations list of protected areas*, Cambridge University Press.
3. Verma, S.B., Sahu, P. and Lal, J. (2009). Water Resource Management, Pentagon Press.
4. Anderson, D.A. (2013) *Environmental economics and natural resource management*, Taylor and Francis.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015) *Ecology, Environment and Resource Conservation*, Sultan Chand Publishing.
6. Imeson, A. (2011) *Desertification, Land Degradation and Sustainability*, Wiley-Blackwell.
7. Loucks, D.P. and Beek, E.V. (2017) *Water Resource System Planning and Management*, Springe

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/4/CC16

MSc/EES/4/CC16	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	3	3	-	2	-	1
CO2	2	3	-	1	2	2	3	2
CO3	2	1	3	3	2	3	3	3
CO4	2	2	1	-	1	-	2	3
Average	1.75	2.25	2.33	2.33	1.66	2.33	2.66	2.25

CO-PSO MAPPING for MSc/EES/4/CC16

MSc/EES/4/CC16	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	3
CO2	3	1	2	3
CO3	3	2	3	2
CO4	-	-	3	2
Average	3	1.33	2.75	2.5

COURSE CODE: MSc/EES/4/CC17
COURSE TITLE: LAB VI- ENVIRONMENTAL BIOCHEMISTRY

Credit: 4 **Marks:100**
Practical Hrs: 4 + 4 **Exam duration: 6 hrs**

COURSE OUTCOMES:
After completion of the course, the student will be able to
CO1: Know the principle and working of spectrophotometer
CO2: Perform spectrophotometric estimation of pigments in plants
CO3: Perform spectrophotometric estimation of essential biochemical compounds in plants
CO4: Perform spectrophotometric estimation of stress related biochemical in plants

1. Principle and working of spectrophotometer
2. Concept and preparation of standard curve
3. Spectrophotometric estimation of Chlorophyll a, Chlorophyll b, Total Chlorophyll
4. Spectrophotometric estimation of Total Carotenoid in plant sample.
5. Spectrophotometric estimation of Total Carbohydrate in plant sample
6. Spectrophotometric estimation of Total Phenol in plant sample.
7. Spectrophotometric estimation of Proline in plant sample
8. Spectrophotometric estimation of Protein in plant sample

CO-PO MAPPING for MSc/EES/4/CC17

MSc/EES/4/CC17	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	2	1	2	1	--	3
CO2	2	2	2	1	2	2	2	3
CO3	2	2	2	1	2	2	2	3
CO4	2	2	2	1	2	2	2	3
Average	2	2	2	1	2	1.75	2	3

CO-PSO MAPPING for MSc/EES/4/CC17

MSc/EES/4/CC17	PSO1	PSO2	PSO3	PSO4
CO1	--	1	2	2
CO2	2	1	2	3
CO3	1	1	2	3
CO4	1	3	2	3
Average	1.25	1.25	2	2.75

COURSE CODE: MSc/EES/9/OEC1
COURSE TITLE: ENVIROMENTAL AWARENESS

Credit: 4 **Marks: 100**
Exam. Duration:3Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:
The purpose of the course is to provide knowledge of structure, functions and distribution of different components of the environment. It imparts knowledge about the concept of global climate change and its impacts on environment and human health. The students will learn about various adaptation and mitigation strategies for global warming and about carbon trading.

COURSE OUTCOMES: On successful completion of the course, the students will be able to
CO1: To acquire the knowledge and understanding of structure, functions and distribution of different components of the environment.
CO2: Understand the concept of changing climate, sources, trends and radiative forcing of greenhouse gases. Gain knowledge of impacts of climate change on different environmental components, ecosystems and human health.
CO3: Explain various national and international programs, protocols and measures to combat the problem of changing climate.
CO4: Develop knowledge about national and international efforts for environmental awareness.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**
Environment: Definition, fundamental concept, components and significance of environment; Definition aims and scope of Ecology; Application and branches of Ecology; Ecosystem: Structure, Function and Services, Ecological pyramids, Food webs, Tropic levels, Primary and secondary production. Biogeochemical cycle: Gaseous cycles and Sedimentary Cycles.

UNIT II **14 Hours**
Global Environmental issues; climate change, Global warming, significance of Ozone layer, Ozone layer depletion, preventive measures to protect Ozone layer depletion, sea level rise, population explosion; pollution and its effects.

UNIT III **14 Hours**
International organisation IPCC (Inter-governmental Panel for Climate change-), UNFCCC (United Nations Framework Conventions of Climate Change), IUCN (International union for Conservation of Nature and Natural Resources), CITES (Convention on international Trade of Endangered Species of Wild Flora and Fauna); National organization (CPCB, MoEF);Non Gov Organizations (TERI, Green peace) and there initiatives.

UNIT IV **14 Hours**
Role of environmental education in environmental awareness, Role of society and people in environmental awareness, Role of electronic, digital and print media in environmental awareness, Tehri movement, Narmada movement, Chipko movement.

Suggested readings:

1. IPCC (Intergovernmental Panel on Climate Change) (1990). *Climate Change: The IPCC Assessment*. Cambridge University Press.
2. Sorokhtin, O.G., Chilingar, G.V. and Khilyuk, L.F. (2007) *Global warming and global cooling: Evolution of climate and earth,* Elsevier.
3. Steffen, W., Sanderson A., Tyson P.D., Jager J., Matson P.M., Moore B., Oldfield F., Richardson K., Schnellnhuber H.J., Turner B.L. and Wasson R.J. (2004) *Global change and the Earth system: a Planet under Pressure*, Springer.
4. Botkin, D.B. and Keller E.A (2004) *Environment Science: Earth as a Living Planet*. John Wiley & Sons Inc.
5. Ricklefs, R.E. (2001). *The Ecology of Nature*, W.H. Freeman and Company.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015) *Ecology, Environment and Resource Conservation*, Sultan Chand Publishing.
7. Steffen, W., Sanderson, A., Tyson, P.D., Jager, J., Matson, P.M., Moore, III, B., Oldfield, F., Richardson, K., Schnellnhuber, H.J., Turner, II, B.L. and Wasson. R.J (2004) *Global change and the Earth System: A Planet under Pressure*, Springer.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/9/OEC1

MSc/EES/9/OEC1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	2	3	-	-	-	2
CO2	3	3	2	1	2	2	3	2
CO3	2	1	3	3	3	2	3	3
CO4	2	2	2	1	-	-	-	2
Average	2	2.25	2.25	2	2.5	2	3	2.25

CO-PSO MAPPING for MSc/EES/9/OEC1

MSc/EES/9/OEC1	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	2	2	3	3
CO3	2	3	3	3
CO4	2	2	3	2
Average	2.25	2.5	2.75	2.5

COURSE CODE: MSc/EES/9/OEC2
COURSE TITLE: DISASTERS MANAGEMENT

Credit: 4 **Marks: 100**
Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

This course gives opportunity for the students to learn about fundamentals, impact and mitigation measures for different types of natural and man-made disaster and also learn different strategies for disaster managements.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To differentiate hazard and disaster arises naturally or caused by human activities and explain fundamental, mechanism, impact and mitigation aspects about different geological and climatological hazards and disaster.

CO2: To explain various types of chemical and biochemical hazards and disasters.

CO3: To explain various disaster managements practices.

CO4: To understand role of different agencies, society, legal support for the disaster management.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **15 Hours**

Introduction to natural Hazards and Disaster; Natural vs. Man-made Disaster; Earthquake and seismic hazards, Earthquake intensity, scales and impacts; Avalanches; Landslides; Volcano; Tsunami; Flood; Cyclone; Cloud burst; Drought.

Unit II **14 Hours**

Chemical and Biological hazards: Outbreak of epidemic and pandemic diseases; Biological warfare; Biological terrorism; Radioactive hazards; Bhopal gas Tragedy; Oil spill.

Unit III **14 Hours**

Disaster management continuum; Disaster Preparedness; Prediction and Mitigation; Post disaster management activities; Impact of hazards on human and environment, learning from Bhola cyclone, Bhuj earthquakes, Indian Ocean tsunami (2004), Exxon Valdez oil spill.

Unit IV **15 Hours**

National and International efforts for disaster management; Role of governmental organization and NGO in disaster management; NDRF; Disaster management act, 2005; Role of mass media and society in disaster management; role of remote sensing in disaster management; relief and rehabilitation.

Suggested reading:

1. Keller, E.A. (2012) *Introduction to Environmental Geology*, Pearson.
2. Rohli, R.V. and Vega, A.J. (2018) *Climatology*, Jones and Bartlett Learning.
3. Hyndman, D. and Hyndman, D. (2016) *Natural Hazards and Disasters*, Brooks/Cole.
4. Singh, J. (2008) *Disaster management*, APH Publishing Corporation.

5. Pipkin, B.W., Trent, D.D., Hazlett, R. and Bierman, P. (2014) *Geology and the Environment*, Cengage.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/9/OEC2

MSc/EES/9/OEC2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	-	-	2	-	1
CO2	2	2	2	1	-	-	-	2
CO3	-	2	-	-	-	2	-	2
CO4	-	-	1	-	2	2	-	2
Average	1.5	1.66	1.33	1	2	2	-	2.33

CO-PSO MAPPING for MSc/EES/9/OEC2

MSc/EES/9/OEC2	PSO1	PSO2	PSO3	PSO4
CO1	3	-	1	1
CO2	2	2	3	1
CO3	-	2	1	2
CO4	-	-	3	2
Average	2.5	2	1.5	1.5

COURSE CODE: MSc/EES/9/OEC3
COURSE TITLE: ENVIRONMENT AND SOCIETY

Credit: 4 **Marks: 100**
Exam. Duration: 3 Hrs **Theory +Internal assessment: 70+30**

COURSE OBJECTIVES:

This course provides the students a comprehensive information of the relation of our society to the environment and also different active organizations, role of public and governmental efforts and initiatives towards environmental conservation.

COURSE OUTCOMES:

After completion of the course, the student will be able

CO1: To understand demography, poverty and population explosion and environmental degradation.

CO2: To understand role of various social movement and society towards environmental conservation.

CO3: To understand environmental ethics and role of various religious traditions of different religions in environmental protection.

CO4: To understand various government initiative for the protection and conservation of natural resources.

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each, selecting at least one question from each unit.

UNIT I **14 Hours**

Demography, poverty and population explosion as environmental problems and their effect on environment; family welfare programmes; role of individual for environmental protection; Self-help groups and environment protection.

Unit II **14 Hours**

Social movement: Chipko, Appiko, save silent valley, Narmada BachaoAndalon, Ecofeminism, Kenyan green belt, movement, role of NGO; Civil Society Organisation; Joint forest movement.

Unit III **14 Hours**

Environmental ethics (ecocentric and anthropocentric); Religious tradition for protection of environment Hinduism, Jainism, Buddhism, Christianity; Islam; Sikhhism; Bishnoi, constitutional provision for environmental protection.

Unit IV **14 Hours**

Government initiative: Swachh Bharat Adhiyan; National Mission for Clean Ganga; concept of aadarsh village, Green Skill Development Programme; Ministry of Environment, Forest and Climate Change; Institution for environment,Ecomark scheme.

Suggested reading:

1. Keller, D.R. (2010) *Environmental ethics*, Wiley & Sons Inc.
2. Suresh, G. and Hampannavar, U.S. (2009) *Environmental studies and ethics*, I K International Publishing House Pvt. Ltd.
3. Bogler, A. (2010) *Environmental awareness*, Oxford.

Teaching-Learning Process

- **Lectures:** Supported by blackboard teaching, PowerPoint presentations, related videos and demonstrations, E-tutoring & E-learning, case study, cooperative learning, problem-solving.
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & sessional tests.

CO-PO MAPPING for MSc/EES/9/OEC3

MSc/EES/9/OEC3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	1	-	-	1	-	1
CO2	1	2	2	-	-	-	-	1
CO3	-	2	1	-	2	3	-	1
CO4	-	1	1	-	-	2	-	1
Average	1	1.75	1.25	-	2	2	-	1

CO-PSO MAPPING for MSc/EES/9/OEC3

MSc/EES/9/ OEC3	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1
CO2	1	1	2	3
CO3	1	3	3	3
CO4	1	2	2	2
Average	1.25	2	2.25	2.25