

PROGRAMME PROJECT REPORT

Master's in Environmental Science (PGEVS) Programme (2 Year Programme)



School of Sciences

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1. Master's Degree Programme

The National Education Policy (NEP) 2020 envisions a new vision that enable an individual to study one or more specialized areas of interest at a deep level, and also develop capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. The NEP 2020 focuses on the formulation of expected learning outcomes for all higher education programmes. It states that “National Higher Education Qualifications Framework (NHEQF)” shall be align with the National Skills Qualifications Framework (NSQF) to ease the integration of vocational education into higher education. It also points out that higher education qualifications leading to a degree/diploma/certificate shall be described by the NHEQF in terms of Outcome Based Education (OBE).

The design of M.Sc.-**Environmental Science** programme in line with NHEQF offers opportunities and avenues to learn core subjects but also to explore additional avenues of learning beyond the core subjects for holistic development of a learner.

The uniform grading system will also enable potential employers in assessing the performance of the learner. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on learner's performance in examinations, guidelines framed by the UGC are followed. Hence, adoption of NHEQF helps to overcome the gap between university degree and employability by introducing skills and competencies in the graduates.

2. M.Sc.-Environmental Science Programme

The structure and duration of postgraduate programme of Master's in **Environmental Science** in accordance with NEP 2020 includes multiple exit options within this period, with appropriate certifications:

- Level 6.5: a **Master in Science (Environmental Science)** programme after 2 years (4 semesters) of study;

2.1 Programme Mission & Objectives

In line with the mission of the University to provide flexible learning opportunities to all, particularly to those who could not join regular colleges or universities owing to social, economic and other constraints, the 2-year Post-Graduate Programme in Environmental Science aims at providing holistic and value-based knowledge and guidance to promote scientific temper in everyday life. The program offers a platform to the learners to fulfill the eligible criteria in various scientific jobs in government and private sector.

The Master of Environmental Science Programme aims at the following objectives:

- Develop a broad academic and practical literacy in environmental science deals with study of socio economic, scientific and technological aspect concern with environmental and resources management, thus the students are able to know understand the physical, chemical and biological nature of environment.

- Provide specialization in different areas such as ecology and biodiversity conservation, environmental chemistry, environmental impact assessment and management, biotechnology, biosafety and IPR.
- Enable students to understand major environmental challenges at local, regional and global scale such as to identify environmental pollution, climate change, global warming, and depletion of natural habitat and energy resources.
- Integrate fields within computer science, optimization, and statistics to developed environmental monitoring skills, including conduct of experiments and data analysis.
- Expose students to real-world problems in the classroom and through experiential learning of modern instrument ion and analytical techniques for environmental analysis.
- These program objectives acknowledge the interdisciplinarity of physical, chemical and biological sciences that make building block of strong foundation with our students.

2.2 Relevance of the Programme with Mission and Goals

The 2-year Post-Graduate Programme in M.Sc.-Environmental Science is designed with the objective of equipping learners to cope with the emerging trends and challenges in the scientific domain. In congruence with goals of the University the Programme also focuses to provide skilled manpower to the society to meet global demands. The Programme is designed in such a manner so that a successful learner can go for higher studies as well as join the research and development industries, pollution abatement projects, central/state pollution control board, environmental monitoring projects and different (NGOs) organizations.

2.3 Nature of Prospective Target Group of Learners

The Program is targeted to all individuals looking to earn a postgraduation degree for employment, further higher education, promotion in career, professional development.

2.4 Appropriateness of Programme to be conducted in ODL mode to acquire specific skills & competence

Learning outcomes after Level 6.5		
Learning Outcomes	Elements of the descriptor	Level 6.5 (Master's in -Environmental Science)
LO 1	Knowledge and understanding	<ul style="list-style-type: none"> • advanced knowledge about a specialized field of enquiry with a critical understanding of the emerging developments • advanced knowledge and understanding of the research principles, methods, and techniques applicable professional practice, • Procedural knowledge required for performing and accomplishing complex and specialized professional tasks relating to teaching, and research and development.
LO 2	Skills required to perform and accomplish tasks	<ul style="list-style-type: none"> • advanced cognitive and technical skills required for performing and accomplishing complex tasks • advanced cognitive and technical skills required for evaluating research findings and designing and conducting relevant research that contributes to the generation of new knowledge, • Specialized cognitive and technical skills relating to a body of knowledge and practice to analyse and synthesize complex information and problems.
LO 3	Application of knowledge and	<ul style="list-style-type: none"> • apply the acquired advanced theoretical and/or technical knowledge about professional practice and a range of cognitive

	skills	and practical skills to identify and analyse problems and issues, including real-life problems, associated with the environmental science.
LO 4	Generic learning outcomes	<ul style="list-style-type: none"> • listen carefully, read texts and research papers analytically and present complex information in a clear and concise manner to different groups/audiences, • communicate, in a well-structured manner, technical information and explanations, and the findings/ results of the research studies. • meet one's own learning needs relating to the chosen fields of learning, work/vocation, and an area of professional practice, • pursue self-paced and self- directed learning to upgrade knowledge and skills, including research-related skills, required to pursue higher level of education and research.
LO 5	Constitutional, humanistic, ethical and moral values	<ul style="list-style-type: none"> • embrace and practice constitutional, humanistic, ethical and moral values in one's life, • adopt objective and unbiased actions in all aspects of work and professional practice, • participate in actions to address environmental protection and sustainable development issues,
LO 6	Employment ready skills, and entrepreneurship skills and mindset	<ul style="list-style-type: none"> • adapting to the future of work and responding to the demands of the fast pace of technological developments and innovations that drive shift in employers' demands for skills, particularly with respect to transition towards more technology-assisted work involving the creation of new forms of work and rapidly changing work and production processes. • exercising full personal responsibility for output of own work as well as for group/ team outputs and for managing work that are complex and unpredictable requiring new strategic approaches.

2.5 Instructional Design

2.5.1 2-year M.Sc.-Environmental Science Programme Structure

The University follows the credit system in all its programmes. One credit is equal to 30 hours of learner's study time which is equivalent to 15 lectures in conventional system. To earn a Master's Degree, a learner has to earn 80 credits in minimum four semesters (two years) with 20 credits per semester. For earning 80 credits, a learner has to go through the following Programme Structure:

Programme Structure of M.Sc.-Environmental Science under NHEQF

Level	Year	Sem	Core Course 1	Core Course 2	Core Course 3	Research component	Practical Lab/ Dissertation with viva voce	Total credit
8	1	1 st	4	4	4	4	4	20
		2 nd	4	4	4	4	4	20
9	2	3 rd	4	4	4	4	4	20
		4 th	4	4	4	4	4	20
Total credit								80

Explanation of terms used for categorization of courses:

- A. **Course 1 to 3:** A course, which should compulsorily be studied by a learner as a core requirement is termed as a Core course.
- B. **Research Component:** The components included in this category are Basics in Research (PGBR-01), Mini Project (PGMP-02), Basic Research Tools (PGRT-03).
- C. **Practical Lab:** Lab based on courses discussed in theory papers.
- D. **Industrial Training/ Survey/ Research Project/ Field Work/Apprenticeship/ Dissertation/Internship:** A course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a learner studies such a course on his own with an advisory support by a counsellor/faculty member.

2.5.2 Course curriculum: The details of syllabus is given in Appendix-I

2.5.3 Language of Instruction: SLM is provided in English. However, learner can write assignment and give Term End Examination (TEE) either in Hindi or English.

2.5.4 Duration of the Programme

Minimum duration in years: 02

Maximum duration in years: 04

2.5.5 Faculty & Support Staff

Director(1), Assistant Professor (3) and support staff (3)

2.6 Instructional Delivery Mechanisms

The Open University system is more learner-oriented, and the student is an active participant in the teaching-learning process. Most of the instructions are imparted through distance rather than face-to-face communication.

The University follows a multi-media approach for instruction. It comprises of:

- self-instructional printed material (Self Learning Material)
- audio and video lectures
- face-to-face counselling
- assignments
- laboratory work
- Project work in some courses
- teleconference/web conference
- Web Enabled Academic Support Portal

2.6.1 Self-Learning Material

The Self Learning Material (SLMs) is prepared in line with the UGC guidelines on preparation of SLMs. The prepared study materials are self-instructional in nature.

The course material is divided into blocks. Each block contains a few units. Lessons, which are called Units, are structured to facilitate self-study. The units of a block have similar nature of contents. The first page of each block indicates the numbers and titles of the units comprising the block. In the first block of each course, we start with course introduction. This is followed by a brief introduction to the block. After the block introduction, emphasis is given on contribution of ancient Indian knowledge into that specific course. Next, each unit begins with an introduction to talk about the contents of the unit. The lists of objectives are outlined to expect the learning based outcome after working through the unit. This is followed by the main body of the unit, which is divided into various sections and sub-sections. Each unit is summarized with the main highlights of the contents.

Each unit have several “Check Your Progress” Questions and Terminal Questions /exercises. These questions help the learner to assess his/her understanding of the subject contents. At the end of units, additional references/books/suggested online weblink for MOOCs/Open Educational Resources for additional reading are suggested.

2.6.2 Audio and Video lectures

Apart from SLM, audio and video lectures have been prepared for some courses. The audio-video material is supplementary to print material. The video lectures are available at YouTube channel of university(https://www.youtube.com/channel/UCj2XTEB6iCZwwIqmKw_jzYg).

2.6.3 Counselling Classes

The face to face (F2F) counselling classes are conducted at head quarter and study centers. The purpose of such a contact class is to answer some of questions and clarify the doubts of learner which may not be possible through any other means of communication. Well experienced counsellors at study centers provide counselling and guidance to the learner in the courses that (s) he has chosen for study. The counselling sessions for each of the courses will be held at suitable intervals throughout the whole academic session. The time table for counselling classes are displayed at head quarter as well as by the coordinator of study center, however, attending counselling sessions is not compulsory. It is noted that to attend the counselling sessions, learner has to go through the course materials and note down the points to be discussed as it is not a regular class or lectures.

2.6.4 Assignments

The purpose of assignments is to test the comprehension of the learning material that learner receives and also help to get through the courses by providing self-feedback to the learner. The course content given in the SLM will be sufficient for answering the assignments.

Assignments constitute the continuous evaluation component of a course. The assignments are available at the SLM section of the home page of university website. In any case, learner has to submit assignment before appearing in the examination for any course. The assignments of a course carry 30% weightage while 70% weightage is given to the term-end examination (TEE). The marks obtained by learner in the assignments will be counted in the final result. Therefore, It is advised to take assignments seriously. However, there will be no written assignments for Lab courses.

2.6.5 Laboratory Work

Laboratory courses are an integral component of the M.Sc. programme. While designing the curricula for laboratory courses, particular care has been taken to weed out experiments not significant to the present-day state of the discipline. Importance has been given to the utility of an experiment with respect to real life experience, development of experimental skills, and industrial applications. It is planned to phase the laboratory courses during suitable periods (such as summer or autumn vacations) so that in-service persons can take them without difficulty. Laboratory courses worth 2 credits will require full-time presence of the student at the Study Centre for one week continuously. During this time a student has to work for around 60 hours. Around 40 hours would be spent on experimental work and the remaining time will be used for doing calculations, preparations of records, viewing or listening to the video/audio programmes.

2.6.6 Teleconference/Web conference

Teleconference/web conference, using done through ZOOM/webex in form of online special counselling sessions is another medium to impart instruction to and facilitate learning for a distance learner. The students concerned would be informed about the teleconferencing schedule and the place where it is to be conducted by sending bulk SMS.

2.6.7 Web Enabled Academic Support Portal

The University also provides Web Enabled Academic Support Portal to access the course materials, assignments, and other learning resources.

2.6.8 Learner Support Service Systems

(a) Study Centre

A Study Centre has following major functions:

- (i) **Counselling:** Counselling is an important aspect of Open University System. Face to face contact-cum-counselling classes for the courses will be provided at the Study Centre. The detailed programme of the contact-cum-counseling sessions will be sent to the learner by the Coordinator of the Study Centre. In these sessions learner will get an opportunity to discuss with the Counsellors his/her problems pertaining to the courses of study.
- (ii) **Evaluation of Assignments:** The evaluation of Tutor Marked Assignments (TMA) will be done by the Counsellors at the Study Centre. The evaluated assignments will be returned to the learner by the Coordinator of Study Centre with tutor comments and marks obtained in TMAs. These comments will help the learner in his/her studies.
- (iii) **Library:** Every Study Centre will have a library having relevant course materials, reference books suggested for supplementary reading prepared for the course(s).
- (iv) **Information and Advice:** The learner will be given relevant information about the courses offered by the University. Facilities are also provided to give him/her guidance in choosing courses.
- (v) **Interaction with fellow-students:** In the Study Centre learner will have an opportunity to interact with fellow students. This may lead to the formation of self-help groups.

(b) Learner Support Services (LSS)

The University has formed an LSS cell at the head quarter. The LSS cell coordinate with the Study Centre to get rid of any problem faced by the learner.

2.7 Procedure for admissions, curriculum transaction and evaluation

2.7.1 Admission Procedure

- (a) The detailed information regarding admission will be given on the UPRTOU website and on the admission portal. Learners seeking admission shall apply online.
- (b) Direct admission to 2-year M.Sc. (Environmental Science) program is offered to the interested candidates.
- (c) **Programme Fee:** Rs. 12000 / year. The fee is deposited through online admission portal only.

2.7.2 Evaluation

The evaluation consists of two components: (1) continuous evaluation through assignments, and (2) term-end examination. Learner must pass both in continuous evaluation as well as in the term-end examination of a course to earn the credits assigned to that course. For each course there shall be one written Terminal Examination. The evaluation of every course shall be in two parts that is 30% internal weightage through assignments and 70% external weightage through terminal exams.

(a) **Theory course**
Terminal Examination

Max. Marks
70

Assignment	30
Total	100
(b) Practical course:	Max. Marks
Terminal Practical Examination	100

Marks of Terminal Practical Examinations shall be awarded as per following scheme:

i.	Write up /theory work	30
ii.	Viva-voce	30
iii.	Execution/Performance/Demonstration	20
iv.	Lab Record	20

The following 10-Point Grading System for evaluating learners' achievement is used for CBCS programmes:

10-Point Grading System in the light of UGC-CBCS Guidelines

Letter Grade	Grade Point	% Range
O (Outstanding)	10	91-100
A+ (Excellent)	9	81-90
A (Very Good)	8	71-80
B+ (Good)	7	61-70
B (Above Average)	6	51-60
C (Average)	5	41-50
P (Pass)	4	36-40
NC (Not Completed)	0	0-35
Ab (Absent)	0	
Q	Qualified	Applicable only for Non-Credit courses
NQ	Not Qualified	

Learner is required to score at least a 'P' grade (36% marks) in both the continuous evaluation (assignments) as well as the term-end examination. In the overall computation also, learner must get at least a 'P' grade in each course to be eligible for the M. Sc. degree.

Computation of CGPA and SGPA

(a) Following formula shall be used for calculation of CGPA and SGPA

For jth semester $SGPA (S_j) = \sum (C_i * G_i) / \sum C_i$	where, C_i = number of credits of the i th course in j th semester G_i = grade point scored by the learner in the i th course in j th semester.
$CGPA = \sum (C_j * S_j) / \sum C_j$	where, S_j = SGPA of the j th semester C_j = total number of credits in the j th semester

The CGPA and CGPA shall be rounded off up to the two decimal points. (For e.g., if a learner obtained 7.2345, then it will be written as 7.23 or if s(he) obtained 7.23675 then it be will written as 7.24)

CGPA will be converted into percentage according to the following formula:

$$\text{Equivalent Percentage} = CGPA * 9.5$$

(b) Award of Division

The learner will be awarded division according to the following table:

Division	Classification
1 st Division	6.31 or more and less than 10 CGPA
2 nd Division	4.73 or more and less than 6.31 CGPA
3 rd Division	3.78 or more and less than 4.73 CGPA

2.8 Requirement of the laboratory support and Library Resources

The practical sessions are held in the science laboratories of the Study Centre. In these labs, the learner will have the facility to use the equipment and consumables relevant to the syllabus. The SLM, supplementary text audio and video material of the various courses of the program is available through the online study portal of the University. The University also has a subscription of National Digital Library to provide the learners with the ability to enhance access to information and knowledge of various courses of the programme.

2.9 Cost estimate of the programme and the provisions

2-year M.Sc. programme consists of 15 theory courses, 4 laboratory courses and (basic research, mini and major project, and Dissertation) research activities. One course is of 4 credits which consist of approx. 12 units. The total approximated expenditure on the development of 15 courses is:

S. No.	Item	Cost per Unit (writing & editing)	Total cost (Rs.)
1	Total no. of units in 12 courses = $15 \times 12 = 180$	5000	900000
2	BOS Meetings etc.	100000	100000
Total			1000000

2.10 Quality assurance mechanism and expected programme outcomes

(a) **Quality assurance mechanism:** The program structure is developed under the guidance of the Board of studies comprising external expert members of the concerned subjects followed by the School board. The program structure and syllabus is approved by the Academic Council of the University. The course structure and syllabus is reviewed time to time according to the feedback received from the stakeholders and societal needs.

The Centre for Internal Quality Assurance will monitor, improve and enhance effectiveness of the program through the following:

- ✓ Annual academic audit
- ✓ Feedback analysis for quality improvement
- ✓ Regular faculty development programs
- ✓ Standardization of learning resources
- ✓ Periodic revision of program depending upon the changing trends by communicating to the concerned school

(b) Expected programme outcomes (POs)

PO1	Demonstrate a fundamental/coherent understanding of the academic in all disciplines of biological/physical science, its different learning areas and applications, and its linkages with related disciplinary areas/subjects
PO 2	Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of environmental related experiments
PO 3	Identify and apply appropriate principles and methodologies to solve different types of environmental problems.
PO 4	Equip students to face the employment challenges and instill confidence to turn into entrepreneur and also step into research career.
PO 5	Generation of new scientific insights or to the innovation of new applications of environmental, chemical and biological research
PO 6	The students will improve their competencies on par with their counterparts in premier institutions across the nation.

Programme specific outcomes (PSOs):	
PSO-1	Learn will be able to understand the fundamental concepts, principle and processes underlying the field of environmental science such as sustainable development, pollution abatement, biodiversity conservation, environmental issue, challenges and their management etc at regional and global scale.
PSO-2	Appreciates the importance of various elements of ecosystem and its factor that govern and regulate the ecological balance, this course also explain the origin and processes of atmospheric activity and its adverse effected on living beings.
PSO-3	Gathers attention about the physical and biological aspects of environmental by analysis of environmental data through using wide range of environmental techniques such as water, air, soil analysis techniques, specially cover, spectroscopic and Electrophoretic techniques. In addition also cover, microbiological, methods, Remote sensing and GIS techniques
PSO-4	It is useful to contact research existing environmental issues and also demonstrate appropriate skill to every emerging problem that rises in field of ecology and environmental or any interdisciplinary sciences.
PSO-5	Learn will be able to get their entrepreneurship because it provide skill in specific areas related to environmental science such as industrial pollution abatement, wastewater treatment and water resources management techniques, techniques of environmental modeling, township and urban planning management, housing and highway contraction project, agriculture and soil health and toxicology and occupational health and safety management etc.
PSO-6	Create awareness on environmental and ethical issue, specially emphasizing on academic and research ethics, scientific misconduct, plagiarism, IPR and biosafety etc.
PSO-7	Carry out laboratory experiments taught in Core Theory papers and to understand good laboratory practices with safety.
PSO-8	Enhance students' ability to develop different environmental management system and model for ecological balance
PSO-9	Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC– NET examination

PSO-10	Discipline specific competitive exams conducted by service commission
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Newly Introduced programme : Yes	
Programme:	Master in Science
Year: NA	First Introduction year:2023
Programme prerequisites: Bachelor degree in concerned subject (B.Sc. (Life Science/ B.Sc. Physical Science/B.Sc. Agriculture/B.Sc. Home Science, and their allied subject	

APPENDIX-I

Detailed Programme Structure & Syllabus M.Sc. Environmental Science Programme Structure

Semester I	Course Code	Title of papers	Credit	Marks	
1 st SEM	PGEVS -101N	Ecosystem and Biodiversity Conservation	4	100	
	PGEVS -102N	Environmental Chemistry	4	100	
	PGEVS -103N	Environmental Microbiology	4	100	
	PGEVS-104 N(P)	Practical's based on PGEVS 101N,102N and 103N	4	100	
	PGBR-01N	Basics in Research	4	100	
Credit I semester			20	500	
2 nd SEM	PGEVS -106N	Numerical and Statistical Computing	4	100	
	PGEVS -107N	Energy Resources and Climate Change	4	100	
	PGEVS -108N	Solid and Hazardous Waste Management	4	100	
	PGEVS -109N(P)	Practical's based on PGEVS 106,107 and 108	4	100	
	PGED-02N	Entrepreneurship Development	4	100	
Credit II semester			20	500	
3 rd SEM	PGEVS -111N	Water Quality and Water Treatment Technology	4	100	
	PGEVS -112N	Remote Sensing and GIS	4	100	
	PGEVS -113N	Plant Stress and Physiology	4	100	
	PGEVS-114N(P)	Practical's based on PGEVS-111N,112N and 113N	4	100	
	PGRT -03N	Research Tools and Practices	4	100	
Credit III semester			20	500	
4 th SEM	Select any one group				
	Group-I	PGEVS-116 N	Geosciences and Natural Resource Management	4	100
		PGEVS-117N	Atmosphere and Ocean Science	4	100
		PGEVS-118N	Environmental Impact Assessment and Management	4	100
		PGEVS -119N(P)	Practical's based on based on PGEVS -116N,117N and 118N	4	100

	OR				
	Group-II	PGEVS-120N	Environmental Toxicology & Occupational Health Hazards	4	100
		PGEVS-121N	Biochemistry and Nanobiology	4	100
		PGEVS-122N	Environmental Biotechnology and IPR	4	100
		PGEVS-123N	Practical's based on based on PGEVS - 120N,121N and 122N	4	100
	Compulsory paper				
		PGEVS-124N(D)	Dissertation/Industrial training/Internship (Viva voce)	4	100
Credit IV semester				20	500
Total course Credit				80	2000

Programme: M.Sc.		Year: 2023-24	Semester: I
Subject: Environmental Science			
Course Code: PGEVS-101N		Course Title: Ecosystem and Biodiversity Conservation	
Course Objectives: <ul style="list-style-type: none">➤ To understand the concept of ecosystem and its role in maintaining our natural balance.➤ To discuss the concepts of ecology and essential ecological processes.➤ To discuss the biodiversity, its conservation and preservation.➤ To understand the Wildlife Protection and Ecotourism.			
Course Outcomes: CO 1: Able to know the concept of ecosystem and ecology CO 2: Gain knowledge about biogeochemical cycle CO 3: Able to know the population ecology and ecological succession. CO 4: Learn the biodiversity and its protection, assessment and conservation. CO 5: Able to do wildlife conservation and ecotourism			
Credits: 4		Type of Course: Core	
Max. Marks: 100		Min. Passing Marks: 36	
Block 1	Ecology and Ecosystem		
Unit I	Ecosystem: Concept, types, structure and function, ecological pyramids, productivity, food chains and food webs, energy models, biogeochemical cycles.		
Unit II	Population Ecology: Ecology and environment, basic concept of population ecology, study of population characteristics-size and density(concept of growth rate), dispersion, age structure, natality, mortality, biotic potential and life table population, inter and intra-specific relation among population.		
Unit III	Community Structure and Ecological Succession: Concept of community, characteristic of community, species diversity, dominance, distribution pattern, tropic level, community dynamics/ecological succession, causes of succession, types of succession, process of succession, monocl原因 and polyclimax theory, ecological niche, habitat, and competitive exclusion principle, ecological hierarchy.		
Block 2	Fundamentals of Biodiversity		
Unit IV	Introduction to Biodiversity: Concept of biodiversity, types of biodiversity, measuring biodiversity, biodiversity hotspots; hotspots in India, loss of biodiversity, factors affecting biodiversity; key		

	stone species, species richness
Unit V	Extinction of Species: Concept of extinction, types of extinctions, processes responsible for species extinction, current and future extinction rates, IUCN categories of threatened species, red book data, list of threatened flora and fauna in India, endangered and endemic species of India.
Unit VI	Values of Biodiversity: Direct/Indirect value of biodiversity, monetizing the value of biodiversity, intrinsic value, ethical and aesthetic value, anthropocentrism, biocentrism, ecocentrism and religions, intellectual value.
Block 3	Conservation of biodiversity
Unit VII	Concept and Strategies: Conservation of biodiversity, national framework for biodiversity conservation, international framework for biodiversity conservation international conventions and treaties for conservation, habitat conservation plan, CBD convention
Unit VIII	Biodiversity Conservation: In-situ conservation, ex-situ conservation, sanctuaries, national parks, tiger reserves and biosphere reserves, formation and management of zoos and zoological parks, central zoo authority of India, captive breeding, role of government and non-governmental organizations in conservation.
Unit IX	Threats to Biodiversity: Habitat destruction, fragmentation, transformation, degradation and overexploitation, causes, impacts of pesticide, water and air pollution on biodiversity.
Block 4	Wildlife Protection and Ecotourism
Unit X	Introduction to Wildlife: Man and wildlife conflict, causes of wildlife depletion; economic importance of wildlife; need for wildlife conservation, endangered flora and fauna of India, Special project for endangered species-project tiger, GIR lion project, tiger reserve project, elephant project, crocodile breeding project.
Unit XI	Wildlife management in India Constitution of state board for wild life, Indian wildlife board, the wild life (protection) act 1972, hunting of wild animals to be permitted in certain cases, protected areas of wildlife, illegal hunting and trade.
Unit XII	Ecotourism: Concept of ecotourism, ecotourism and the environment, importance of ecotourism, ecotourism resources, understanding ecotourism resource categories, ecotourism and education, ecotourism and protected areas, ecolabeling and greenbelt, impact of ecotourism in society.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Science, Subhas Chandra Santra, new central book agency, 3rd Edition, 2011 2. A text Book of Environment Studies, Asthana, D. K. and Asthana, M. 2006, S. Chand & Co 3. Atmosphere, Weather and Climate, Barry, R. G. 2003, Routledge Press, UK. 4. Ecology: Theories and Applications (4th Edition) by Peter Stiling; Prentice Hall. 5. Biodiversity: a beginner's guide, John I. Spicer, One world Publications. Suggested online link: <ol style="list-style-type: none"> 1. Principle of ecology, UGC-MOOCs SWAYAM. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view Ug/156 2. Environmental Science, Dr. Y. K. Singh, https://www.hzu.edu.in/bed/E%20V%20S.pdf 3. 	

3. Textbook for Environmental Studies, Erach Bharucha, https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf
4. Guidelines on Sustainable Eco-Tourism in Forest and Wildlife Areas 2021: MOEFCC.pdf (mpforest.gov.in)
5. Biodiversity and its Conservation: PK (AECC-EVS) Chapter - 4 Biodiversity.pdf (dducollegedu.ac.in)
This course can be opted as an elective by the students of following subjects: MA (Geography), BTS, M.Sc. (Botany), M.Sc. (Zoology)
Suggested equivalent online courses (MOOCs) for credit transfer: Biodiversity and Ecological Resources: Biodiversity and Ecological Resources - Course (swayam2.ac.in)

Programme: M.Sc.	Year: 2023-24	Semester: I
Subject: Environmental Science		
Course Code: PGEVS-102N	Course Title: Environmental Chemistry	
Course Objectives: <ul style="list-style-type: none">➤ To discuss the atmospheric composition and its role in ecological process➤ To discuss the ozone chemistry and its role in protection of living beings➤ To discuss the environmental pollution and its types and abetments➤ To discuss abut different instrumental techniques used in detection of environmental sample		
Course Outcomes: CO 1: Able to know the physical and chemical characteristic of atmospheric gases CO 2: Learn the nature of greenhouse gases and it role in global warming CO 3: Learn the chemistry of water, wastewater and industrial effluent. CO 4: Gain knowledge about air and water sampling CO 5: Able to do the air prevention and control of pollution		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Atmospheric Chemistry and Pollution	
Unit I	Atmospheric composition and Pollution: Composition of air, air pollutants, primary and secondary air pollutants, indoor/outdoor air pollution, source, sink and chemistry of air pollutants-carbon monoxide (CO), Nitrogen Oxide (NO _x), Sulphur Oxide (SO _x), hydrocarbon, and particulates matter, smog, acid rain, greenhouse and greenhouse effect, global warming potential of gases and its effects.	
Unit II	Ozone Chemistry and Photochemical Smog: Atmospheric ozone, formation and depletion of ozone in stratosphere, ozonein arctic region, free radicals and its role in ozone depletion, ozone depletion and climate change, Montreal protocol, Smog (London/Los Angeles), peroxyacetyl nitrate (PAN).	
Unit III	Sampling and Air Pollution Abatement: Sampling of gases, adsorption and absorption of gas, types of particulate matter, collection equipment, settling chamber, cyclones, filters, electrostatic precipitator, scrubber and wet collector, control of particulate matter	
Block 2	Water Chemistry and Pollution	
Unit IV	Properties of Water: Structure of water molecule, chemical composition of river, ocean, lake water, chemical bonding in water, unique properties of water, water as solvent.	

Unit V	Water pollution: Definition of water pollution, source and types of water pollutants, Marine pollution, oil pollution, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved organic carbon (DOC), and total dissolve solid (TDS) and total suspended solid.
Unit VI	Wastewater and Industrial Effluents Meaning of wastewater, industrial effluent, composition of industrial effluents, sludge and activated sludge; Eutrophication, Role of soaps, detergents and phosphorus fertilizers in eutrophication; pathogenic bacteria, wastewater treatment, application of advanced oxidation processes.
Block 3	Soil and Noise Pollution
Unit VII	Soil Pollution: Characteristics of soil, soil chemical composition, soil pollutants and its sources, soil carbon, essential elements of soil, soil fertility, cation exchange and anion exchange capacity, exchangeable sodium percentage, significance of soil ion exchange, soil pH and acidity of soil, nitrogen cycle.
Unit VIII	Noise Pollution: Noise pollution-sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans; control measures.
Unit IX	Industrial Pollution: Chemical solvents used in dyeing, tanning, metallurgical and platinum industry, Burning fossil fuels like coal, oil, natural gas, and petroleum, heavy metals pollution.
Block 4	Environmental Sampling and Control of Pollution
Unit X	Radioactive and Thermal Pollution Nuclear power plants based waste material, radioactive waste, biological and chemicals release from war, thermal pollution and its effects.
Unit XI	Instrumental Techniques: Principle and application of atomic absorption spectrophotometer (AAS), Inductive couple plasma emission spectroscopy (ICPES), X-Ray fluorescence, Fourier transforms infrared spectroscopy (FTIR), ion selective electrode for air, water and soil sample analysis.
Unit XII	Air prevention and Control of pollution: Air (prevention & control of pollution) act 1981 as amended by amendment 1987 & rule 1982, motor vehicle act, 1988, the environment (protection) act 1986, rules 1986, the national green tribunal act 2010.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Science, Subhas Chandra Santra, new central book agency, 3rd Edition, 2011 2. A text Book of Environment Studies, Asthana, D. K. and Asthana, M. 2006, S. Chand & Co 3. Environmental Chemistry, A.K. De, New Age Publisher International Pvt Ltd 4. Textbook of Environmental Chemistry and Pollution Control, S.S.Dara and D.D. Mishra, S Chand & Co Ltd Suggested online links: <ol style="list-style-type: none"> 1. Environmental Science, Tom Theis and Jonathan Tomkin, OpenStax CNX, National Digital Library of India. http://ndl.iitkgp.ac.in/document/N2tzeE1aWWpUMm04b2l1VVZEdSsvK09RckFISkE0OWI3b1Flb2ZTNHFxST0 2. Textbook for Environmental Studies, ErachBharucha, https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf 	

3. Environmental Pollution: Lesson 10.pmd (shivajicollege.ac.in)
4. Instrumental Methods Of Analysis: SCY2.pdf (sathyabama.ac.in)
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer: NA

Programme: M.Sc.	Year: 2023-24	Semester: I
Subject: Environmental Science		
Course Code: PGEVS-103N	Course Title: Environmental Microbiology	
Course Objectives: <ul style="list-style-type: none">➤ To discuss the microbial diversity, nutrition, culture and microbial techniques➤ To discuss about air water and soil microbes and it is role in environment➤ To discuss the role of microbes in agriculture.➤ To discuss the microbial diseases and its role as antibiotics substances		
Course Outcomes: CO 1: Able to know the concept of microbial growth and culture media. CO 2: Learn about microbial integration and microbial techniques. CO 3: Able to know the role of microbial diversity in soil, water and air. CO 4: Gain knowledge about microbial degradation of organic matter. CO 5: Also know about disease and antibiotics activity of microbes.		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Microbial Diversity and Microbial Techniques	
Unit I	Microbial Diversity: Modern approaches to bacterial taxonomy, polyphasic classification, general characteristics of primary domains and of taxonomic groups belonging to bacteria, archaea and Eukarya.	
Unit II	Culture Media and Nutrition: Construction of culture media, types of microbial culture media, principles of microbial nutrition, microbial nutritional types and modes of nutrition in bacteria.	
Unit III	Microbial Techniques: Theory and practice of sterilization, pure culture techniques, enrichment culture techniques, isolation and culture of aerobic and anaerobic bacteria, preservation and maintenance of microbial cultures.	
	Microbial Growth and Interaction: Microbial growth, growth curve, measurement of growth and growth yields, synchronous growth and continuous culture, microbial interaction, positive and negative integration.	
Block 2	Soil Water and Air Microbiology	
Unit IV	Soil Microbiology: Soil as habitat for microbiology, soil microbes-algae, bacteria, actinomycetes, bacteriophage, protozoa, nematodes and fungi;microbial	

	balance, rhizosphere and rhizoplane microorganism.
Unit V	Water Microbiology: Water as habitat for microbiology, water microbiology-fresh and marine water microbes, microbial analysis of water-coliforms test, purification of water by microbes, microorganism associated with organic matter decomposition in water.
Unit VI	Microbiology of Air: Define aeromicrobiology, aerofungi, and aeromicroflora of pharmacy, aeromicroflora of hospital and other houses, phylloplane microflora, phylloplane pathogens, characteristic of phylloplane microflora.
Block 3	Agriculture Microbiology
Unit VII	Microbial Biofertilizers: Microbial inoculants, inoculants carrier, production of microbial fertilizers, algae biofertilizers, cyanobacteria biofertilizers, mycorrhizal biofertilizers, and phosphorous adding biofertilizers.
Unit VIII	Microbial Biopesticides: Microbial insecticides, microbial herbicides, pseudomonas as bacterial insecticides, bacillus species as bacterial insecticides, virus insecticides.
Unit IX	Microbial degradation: Sewage degrading microorganism, microbial degradation of petroleum, microbial degradation of xenobiotics compound, microorganism in abatement of heavy metal pollution, heavy metal tolerance in microbes
Block 4	Microbes in Organic Matter and Microbial Diseases:
Unit X	Microorganism of Organic Matter: Microorganism associated with organic matter decomposition-cellulose, hemicelluloses, lignin and proteins, carbon assimilation and immobilization, factor effecting microbial community in soil.
Unit XI	Microbial diseases: Bacterial and virus diseases with reference to tuberculosis, cholera, AIDS, Rabies, food born diseases.
Unit XII	Chemotherapy/Antibiotics: Antimicrobial agents, Antibiotics, penicillins and cephalosporins and broad- spectrum antibiotics, sulfa drugs, antifungal antibiotics
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. R.C. Dubey and D.K. Maaheshwari, A Textbook of Microbiology, S. Chand Publication-2013. 2. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, A Microbiology, Academic Press-2015. 3. K Vijaya Ramesh , Environmental Microbiology, MJP Publication-2019. 4. P.K. Mahapatra, A Textbook of Environmental Microbiology, I K International Publishing House Pvt. Ltd-213. 5. Barbara Kolwzan et al., Introduction To Environmental Microbiology, academic teachers from Wroclaw University of Technology, Poland Suggested online links: <ol style="list-style-type: none"> 1. Introductory Microbiology, UGC-MOOCs SWAYAM. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view ug/74 2. Soil Microbiology: https://www.edouniversity.edu.ng/oerrepository/articles/mcb_313_soil_microbiology_20182019.pdf 3. AIR MICROBIOLOGY: https://prog.lmu.edu.ng/colleges_CMS/document/books/MCB%20316%20- 	

%20first%20NOTE.pdf 4. Water microbiology: 5. https://gurujistudy.com/bsc-microbiology-of-water-notes-study-material/ 6. AGRICULTURAL MICROBIOLOGY: https://www.rvskvv.net/images/I-Year-II-Sem_Agricultural-Microbiology_ANGRAU_20.04.2020.pdf
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer: 1. Applied Environmental Microbiology: <u>Applied Environmental Microbiology - Course (nptel.ac.in)</u>

Course prerequisites: None	
Programme: M.Sc./M.A.	Year: I
Subject: Statistics	
Course Code: <i>PGBR-01</i>	Course Title: <i>Basics in Research</i>
Course Objectives: The main objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods, survey, Plagiarism and copyright issue.	
Course Outcomes:	
CO1: To write a good qualitative research statement and design the research questions.	
CO2: To know about the hypothesis, conduct the survey and a qualitative case study.	
CO3: Able to know the Plagism and copyright issue for writing research paper and project.	
Credits: 4	Type of Course: Core
Max. Marks: 100	Min. Passing Marks: 36
BLOCK 1	Basic of Research
Unit 1	Introduction to Research: Knowledge and the Approaches of Acquiring knowledge (deductive, inductive and scientific), Meaning of Research, Objectives of Research, Motivation in Research, Significance of Research, Importance of knowing How Research is Done?, Criteria of Good Research
Unit 2	APPROACHES OF RESEARCH: Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method, Research Process
Unit 3	DEFINING THE RESEARCH PROBLEM: What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Technique involved in Defining a Research Problem.
Unit 4	RESEARCH DESIGN: Need for Research Design, Features of Good Design, Important Concepts Relating to Research Design, Different Research Design, Basic Principles of Experimental Designs.
BLOCK 2	LITERATURE SURVEY, REVIEW, AND SYNOPSIS PREPARATION
Unit 5	Literature Survey: Introductions: Sources of information, need for reviewing literature, primary-secondary and tertiary sources, journals, abstracts, text books, Web resources, E-journals, journal access, case study alerts. Citation index, UGC infonet, E-books, Impact Factors, Search engines- Google scholar, Science Direct, SciFinder, Scopus, web of science.
Unit 6	Literature Review: Establishing the Context, Identifying Gaps in Knowledge, Formulating Research Questions or Hypotheses, Defining Key Concepts and Terms, Selecting Research Methods, Supporting Research Design and Methodology, Evaluating Research Methods, Citing Relevant Studies, Avoiding Redundancy, Synthesizing Knowledge, Demonstrating Scholarly Engagement, Guiding the Organization of Your Research Paper, Providing a Theoretical Framework, Supporting Ethical Research, Contributing to the Research

	Conversation, Types of Review of literature.
Unit 7	Preparation of Research Synopsis: The structure of synopsis- Title, Introduction, Literature Review, Research Questions or Hypotheses, Methodology, Data Collection, Data Analysis, Expected Outcomes and Significance, Timeline, References, Budget, Appendices.
BLOCK 3	ETHICS AND IPR
Unit 8	Research Ethics: Regulatory bodies, practices and compliances, Good Laboratory Practices (GLP), Research Ethics & Misconduct.
Unit 9	Intellectual Property Rights: Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties. Plagiarism, Patents, Fundamentals of patents, Product and process patent, Patent Treaties and Convention, process of filing patent (Search and retrieval), copyrights, geographical indications, design and layout, trademarks.
Unit 10	Ethical consideration for research: Informed Consent, Privacy and Confidentiality, Minimizing Harm and Risks, Beneficence, Justice and Fairness, Deception, Publication Ethics, Peer Review, Conflict of Interest, Animal Welfare, Data Management and Sharing, Community and Stakeholder Involvement, International Research Ethics.
BLOCK 4	RESEARCH REFERENCE, REPORT AND PAPER WRITING
Unit11	Reference Writing: APA Style (American Psychological Association), MLA Style (Modern Language Association), Chicago Style, IEEE Style (Institute of Electrical and Electronics Engineers), AMA Style (American Medical Association), Harvard Style, Vancouver Style, Turabian Style, CSE Style (Council of Science Editors), Bluebook Style. Tips for writing references.
Unit12	Report writing in academics and research: Various kinds' of academic and research activities. Necessity of report writing for achievement of academic and research goals. Various kinds of reports / presentations. Characteristics of academic and research reports / presentations. Conclusions. Scientific Writing – Introduction to Technical writing, definition, types, characteristics, Report Writing, Research proposal writing.
Unit13	Research paper writing: Choose a Topic, Conduct a Literature Review, Formulate a Research Question or Hypothesis, Plan Your Research, Gather Data, Organize Your Research, Write an Outline, Write the Introduction, Literature Review, Methodology, Results, Discussion, Conclusion, Cite Your Sources, Proofread and Edit, Formatting and References, Finding a Suitable Journal, Submit Your Paper, Peer Review and Revision, Final Proofreading.
Block 5	RESEARCH TOOLS AND STATISTICAL METHODS
Unit 14	Basics of Data, Research Tools, and Types of Variables- Research Tools for Data Collection- Questionnaire , Structured vs. Semi-structured, Open-ended and closed-ended questions, Interview Schedule -Face-to-face, telephonic, or digital, Observation Method , Participant and non-participant observation- Checklist and Rating Scale , Likert scales, semantic differential scales, Dietary Assessment Tools , 24-hour recall, food frequency questionnaire (FFQ), food diary, Anthropometric Measurement Tools , Weighing scale, stadiometer, measuring tape, MUAC, BMI chart. Types of Data and Variables -Qualitative vs. Quantitativ, Nominal, Ordinal, Interval, Ratio, Dependent and Independent Variables. Understanding Data Distributions - Normal and skewed distributions, checking normality: Histogram, Q-Q Plot, Shapiro-Wilk test.
Unit 15	Parametric Statistical Tools and Applications- Descriptive Statistics (Parametric) , Mean, Median, Mode, Standard Deviation, Variance, Percentiles and Z-scores, Inferential Parametric Tests, t-tests , One-sample t-test, Independent samples t-test, Paired samples t-test, One-way ANOVA , F-test, post-hoc interpretation, Correlation and Regression , Pearson correlation, Simple Linear Regression (assumptions, interpretation, R^2), Confidence Intervals and p-values , Interpretation and significance, Tools Used: MS Excel, SPSS, Examples: Comparing mean hemoglobin between groups, Predicting BMI from daily calorie intake.

Unit 16	Non-Parametric Statistics and Risk Estimation Tools-Descriptive Statistics (Non-Parametric), Median, Mode, Interquartile Range, Non-Parametric Tests, Chi-square Test, Test of independence using contingency tables, Mann-Whitney U Test, Comparison of two independent groups, Wilcoxon Signed-Rank Test, Paired samples, Kruskal-Wallis Test, Non-parametric ANOVA alternative, Risk Estimation Tools, Odds Ratio (OR), Use in case-control studies, Interpretation, Relative Risk (RR), Use in cohort studies, 2x2 tables, Manual and SPSS calculation, Tools Used: SPSS, Manual calculation using examples, Examples: Association between junk food and obesity, Risk of anemia based on dietary habits.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. C.R. Kothari, Gaurav Garg. Research Methodology: Methods and Techniques, New Age International Publishers, 2019. 2. Kumar. R: Research Methodology: A Step-by-Step Guide for Beginners, (3rd Edition), SAGE, Inc., 2011. 3. https://onlinecourses.swayam2.ac.in/cec22_ge28/preview 	

Programme: M.Sc.	Year: 2023-24	Semester: II
Subject: Environmental Science		
Course Code: PGEVS-106N	Course Title: Numerical and Statistical Computing	
Course Objectives: <ul style="list-style-type: none">• To discuss the role of statistics in sampling and data management• To discuss the descriptive statistics and analysis of variance.• To discuss fundamentals of computer and statistical software.		
Course Outcomes: CO 1: Gain knowledge about sampling and data analysis CO 2: Learn about mean, median mode and other statistical tools of data analysis and management. CO 3: Able to understand about hypothesis and hypothesis test for data analysis. CO 4: Able to do regression, probability and variance analysis on data CO 5: Also known to run statistical computing and R software for data analysis .		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Descriptive statistics	
Unit I	Data and Sampling Data and Statistical Data, Frequency Distribution, Graphical and Diagrammatical Representation, Inter-Relationships of Graphs, Introduction and Types of Sampling, Sampling Distribution.	
Unit II	Descriptive Statistics: Measure of Central Tendency, (Mean, Median, Mode), Measures of Dispersion, (Range, Mean Deviation, Standard Deviation, Variance), Coefficient of Variation, Skewness and Kurtosis	
Unit III	Correlation and Regression Analysis Scatter Diagram, Karl Pearson's Coefficient of Correlation, Properties of Correlation Coefficient, Limits of Correlation Coefficient, Pearson's Coefficient, Spearman's Coefficient, Regressions and Linear Regression Model, Principle of Least Square, Regression Lines, Regression Coefficient, Properties of Regression Coefficients.	
Block 2	Probability and Testing of Hypothesis	
Unit IV	Probability & Distribution Theory: Probability, Additive and Multiplicative Law of Probability, Conditional Probability, Probability Mass Functions, Probability Density Functions, Binomial	

	Distribution, Poisson Distribution and Normal Distribution.
Unit V	Theory Of Hypothesis: Hypothesis and its Types, Signification Level, Critical Region, Degree of Freedom, P Value, Types of Error, Z-test, t-test, F-test and Chi-Square Tests with its applications.
Unit VI	ANOVA (Analysis Of Variance): Introduction to ANOVA, Analysis of Variance One Way and Two Way Classification, ANOVA with Missing Observation (One and Two Missing observations), Analysis of Covariance.
Block 3	Introduction to Computer
Unit VII	Computer Basics: Computer and its Characteristics, Computer Generation and Classification Problem-Solving Using Computers.
Unit VII	Hardware and Software: Central Processing Unit (CPU), Memory Organization, Input And Output Device, System Software, Files Commands, Editing Commands.
Unit IX	MS Office: Word Processing Software- Microsoft Office Word, Spread Sheet Software- Microsoft Office Excel, Presentation Software- Microsoft Office-Power Point, Excel As Data Base Software.
Block-4	Computational analyses
Unit X	Algorithm and Flow Charts: Introduction, Objectives And Example Of Algorithms, Characteristics Of Algorithms, Various Analyses Of Algorithms, Flow Chart And Its Characteristics.
Unit XI	Computation with MS Excel: Function Specifically, Numeric/Mathematical Functions, Statistical Functions, Logical Function, Loop Functions, Statistical Analysis Using Excel-Descriptive Statistics, Curve Fitting, Correlation And Regression Analysis And Graphs.
Unit XII	Statistical Software: Brief introduction about Statistical Software (SPSS, R etc), Basics of R, R Studio, Creation of Data File, Statistical Analysis with R
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Introduction to Statistics, David Lane, Rice University 2. Basic Statistics, B.L. Agrawal, New Age International Private Limited 3. Basic Statistics, Thomas Higher Education Textbooks 4. Computer Fundamentals : Concepts, Systems & Application, Priti Sinha, Pradeep K., Sinha , BPB Publications 5. The Book of R: Tilman M. Davies, San Francisco Suggested online links: <ol style="list-style-type: none"> 1. Introduction to Descriptive Statistics: introduction-to-descriptive-statistics.pdf 2. Descriptive Statistics: Slide 1 (incois.gov.in) 3. Basic Probability Theory: 46628-0 Ash 1 (illinois.edu) 4. Probability Theory: https://faculty.math.illinois.edu/~r-ash/BPT/BPT.pdf 	
This course can be opted as an elective by the students of following subjects: Any one	
Suggested equivalent online courses (MOOCs) for credit transfer: <ol style="list-style-type: none"> 1. Computer Fundamentals: Computer Fundamentals - Course (swayam2.ac.in) 2. Descriptive Statistics: Descriptive Statistics - Course (swayam2.ac.in) 	

Programme: M.Sc.	Year: 2023-24	Semester: II
Subject: Environmental Science		
Course Code: PGEVS-107N	Course Title: Energy Resources and Climate Change	
Course Objectives: <ul style="list-style-type: none">To discuss the source of energy in nature and its role in regulation of ecosystemTo discuss about solar radiation and energy budgetTo discuss global warming and its effect on living beingsTo discuss the climate change and policy Frameworks		
Course Outcomes: CO 1: Able to understanding the source of energy in nature. CO 2: Understanding the concept energy and energy budget CO 3: Learn about conventional-nonconventional energy and its conservation CO 4: Able to learn concept of global warming and climate change CO 5: Also discuss on energy polices and Indian climate panel		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Environmental Physics	
Unit I	Introduction to environmental Physics: Concept and scope of environmental physics with respect to human environment, built environment; laws of thermodynamics, irreversible thermodynamics and entropy, heat balance (steady and transient).	
Unit II	Solar Radiation: Electromagnetic radiation, thermal regulation in buildings- thermal insulation, thermal conduction effects, convection effects, radiation effects, u-values, energy flow diagram to the earth.	
Unit III	Energy Budget: Energy use and efficiency in buildings. Energy losses, calculation of energy losses, energy gains, Air regulation in buildings, heat pumps, condensation.	
Block 2	Energy Resources	
Unit IV	Concept of Energy: Definition and units of energy, types of energy resources, conventional-nonconventional, renewable-nonrenewable energy resources, energy tools and techniques of energy conservation, origin and time scale of fossil fuels production.	
Unit V	Energy Flow Models: Basic or universal model, energy flow models of aquatic ecosystems and terrestrial ecosystem, comparison of energy flow in different ecosystems, Lindeman’s trophic dynamic aspect.	
Unit VI	Politics of Energy Policy: Political choices in energy policy globally and in the Indian context (historical and contemporary case studies), domestic and international energy policy, energy diplomacy and bilateral ties of India with her neighbor.	
Block 3	Climate Change and Global Warming	
Unit VII	Introduction to Climate Change: Definition, scope and facts of climate change, earth energy budget, composition and thermal structure of atmosphere, origin and types of wind, wind speed & direction, weather and climate, temperature, pressure, precipitation, humidity.	
Unit VIII	Monsoons: Definition of monsoon, winter, summer and rainy season of Indian monsoon, cyclones of the Indian region; El-Nino, La Nina, and IOD and their impacts.	

Unit IX	Greenhouse Effect and Global Warming: Greenhouse gases causes and effects, sources and sinks of greenhouse gases; urban heat islands; ozone layer depletion and recovery, issues and remedies; ground level ozone and air pollution; global dimming, carbon footprint.
Block 4	Climate Change and Policy Frameworks
Unit X	Impacts of Global Climate Change: Increased surface mean temperature, insect outbreaks, vector borne/zoonotic diseases, forest fire, reduced water availability, loss of biodiversity and extinction of species, sea level rise, and food security.
Unit XI	Climate Change and Policy Frameworks: History of international climate change policies, united nation framework, convention on climate change (UNFCCC), intergovernmental panel on climate change (IPCC).
Unit XII	Indian Climate Panel: Ministry of environment, forests & climate change (MOEF&CC), national action plan on climate change (NAPCC), agenda 21, the Kyoto protocol, Paris agreement.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Science, Subhas Chandra Santra, new central book agency, 3rd Edition, 2011 2. Non conventional Energy Resources, D.S. Chauhan, New Age International. 3. Renewal Energy Technologies: A Practical Guide for Beginners, C.S. Solanki, PHI Learning. 4. Advances in Energy System and Technology, Peter Auer, Vol. 1 & II Edited by Academic Press. Godfrey, “ Renewable Energy Power For A Sustainable Future, Boyle, Oxford University Press. 5. Introduction to Energy and Climate , Developing a Sustainable Environment, Julie Kerr, Taylor & Francis eBooks Suggested online links: <ol style="list-style-type: none"> 1. Solar radiation: 1511327362Paper7_EnergyEnv_module_2_etext-Solarradiation.pdf 2. Sun as source of energy: 1522993850Paper7__module_1_etext.pdf 3. Renewable energy resource: 1522993850Paper7__module_1_etext.pdf 4. Energy flow model in ecosystem :http://www.dspmuranchi.ac.in/pdf/Blog/aksinghdspmuranchiacinA13.pdf Introductory e-Course on Climate Change: file:///C:/Users/HP/Downloads/Introductory%20eCourse%20on%20Climate%20Change_Syllabus.pdf	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Programme: M.Sc.	Year: 2023-24	Semester: II
Subject: Environmental Science		
Course Code: PGEVS-108N	Course Title: Solid and Hazardous Waste Management	
Course Objectives: <ul style="list-style-type: none">To discuss different types of waste generated from different sources in natural habitatTo discuss sources risk and management of municipal solid waste, its characterization reuseTo discuss characterization, handling and management of medical and hazardous wasteTo know how to use, reuse and recycle of solid and other waste		
Course Outcomes: CO 1: Abe to know the types and characteristic of solid waste generated from different sources. CO 2: Learn about the industrial hazardous waste and its characteristics CO 3: To know how to handling and mange the medical waste in hospital and dumping site CO 4: Able to know the concept reduce recycling and reuse of waste materials CO 5: Lear to handling and management of hazardous waste		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Municipal Solid Waste	
Unit I	Introduction of Solid waste: Definition of waste, sources and generation of solid waste, their classification and chemical composition, waste characterization, impact of solid waste on environment, human and plant health.	
Unit II	Municipal and Industrial Solid Waste: Definition, sources and generation of municipal solid waste, their classification, composition of municipal solid waste (MSW), composition and state of municipal solid waste in India.	
Unit III	Disposal of Solid Wastes: Segregation and sorting, various methods for solid waste disposal, incinerations, sanitary landfill, advantages and disadvantages of sanitary land fill.	
Block 2	Hazardous and Biomedical Waste	
Unit IV	Hazardous Waste: Definition, sources, classification of hazardous waste, characterization of hazardous waste, collection and segregation, treatment and disposal.	
Unit V	Hazardous Waste Treatment Methods: Physical and chemical hazardous waste treatment methods, thermal treatment methods, Biological treatment of hazardous wastes.	
Unit VI	Biomedical wastes: Definition, sources, classification, collection and segregation of biomedical waste, Biomedical Wastes Handling Rules, treatment and disposal of biomedical waste, standards for treatment and disposal of bio-medical wastes.	
Block 3	Radioactive Waste and Waste Recycling	
Unit VII	Radioactive and Plastic Wastes: Definition, sources, classification, collection, segregation, treatment and disposal of radioactive waste, plastic waste-source, classification and disposal, microplastic.	
Unit VIII	E-Waste: Concept of e-waste, types and source of e-waste, collection strategy of e-waste, treatment of e-waste, recycle, reduce and reuse of e-waste, e-waste management in India.	

Unit IX	Resource Recovery: 4R- reduce, reuse, recycle and recover of waste, biological processing-composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.
Block 4	Waste Management Handling and Rules
Unit X	Solid Waste Management: Solid waste management rules 2016, evolution of SWM rules in India, municipal solid wastes (management and handling) rules 2000, criteria for waste to energy process, plastic waste management rules 2016.
Unit XI	Hazardous and Medical Wastes Management: Hazardous wastes management and handling rules 1989, hospital waste management, bio-medical waste (management and handling) rules 1998.
Unit XII	E-Waste Management: Procedure for storage of e-waste, e-waste management rules 2016, e-waste regulation in India, state government for the management of waste, procedure for authorization for management of e-waste.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Waste treatment and disposal, Williams, Paul T. John Wiley Publishers, 2013. 2. E-waste: Implications, regulations and management in India and Current global best practices, TERI press, Johri, Rakesh. 3. Bio- medical waste management, Sahai, Sushma, APH Publishing. 4. Electronic waste management, design, analysis and application, R E Hester ,Cambridge Royal Society of Chemistry 5. Solid and Hazardous Waste Management, Rao, M.N. and Sultana ,BS Publications, Hyderabad Suggested online link: <ol style="list-style-type: none"> 1. E-waste management: https://www.epa.gov/sites/default/files/2014-05/documents/india.pdf 2. Municipal Waste (Management and Handling) Rules: 1519297109paper11_module_37_etext.pdf 3. Medical Waste Management: https://www.icrc.org/en/doc/assets/files/publications/icrc-002-4032.pdf 4. Solid waste composting: 1511177780Paper_11_module_26_yoga_etext.pdf 5. Composition of solid waste: 1511174041Paper_11_module_5_yoga_etext.pdf 	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: <ol style="list-style-type: none"> 1. Solid and Hazardous Waste Management: <u>Solid and Hazardous Waste Management - Course (swayam2.ac.in)</u> 	

Course prerequisites: None			
Programme: M.Sc./M.A.		Year: I	Semester: III
Subject: Mathematics			
Course Code: <i>PGED-02</i>		Course Title: Entrepreneurship Development	
Credits: 4		Type of Course: Core	
Max. Marks: 100		Min. Passing Marks: 36	
BLOCK 1	BASIC CONCEPTS		
Unit 1	Meaning, Definition and concept of Enterprise, Entrepreneurship and Entrepreneurship Development		
Unit 2	Evolution of Entrepreneurship, Theories of Entrepreneurship. Characteristics and Skills of Entrepreneurship		
Unit 3	Concepts of Entrepreneurship, Entrepreneur v/s Entrepreneur, Entrepreneur Vs. Entrepreneurship, Entrepreneur Vs. Manager		
Unit 4	Role of Entrepreneurship in Economic Development, Factors affecting Entrepreneurship, Problems of Entrepreneurship.		
BLOCK 2	ENTREPRENEURIAL COMPETENCY, MOBILITY AND MOTIVATION		
Unit 5	Meaning and concept of Entrepreneurial Competency, Developing Entrepreneurial Competencies, Entrepreneurial Culture		
Unit 6	Entrepreneurial Mobility, Factors affecting Entrepreneurial mobility, Types of Entrepreneurial mobility		
Unit 7	Entrepreneurial Motivation: Meaning and concept of Motivation, Motivation theories.		
Unit 8	Entrepreneurship Development Program: Needs and Objectives of EDPs, Phases of EDPs, Evaluation of EDPs		
BLOCK 3	ROLE OF GOVERNMENT AND ITS ORGANIZATION		
Unit 9	Role of Government in promoting Entrepreneurship, MSME policy in India		
Unit 10	Agencies for Policy Formulation and Implementation: District Industries Centers (DIC)		
Unit 11	Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII).		
Unit12	National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB)		
Unit13	Financial Support System: Forms of Financial support, Long term and Short term financial support, Sources of Financial support, Development Financial Institutions, Investment Institutions		
BLOCK 4	WOMEN ENTREPRENEURSHIP		
Unit14	Women Entrepreneurship: Meaning, Characteristic features, Problems of Women Entrepreneurship in India, Developing Women Entrepreneurship in India		
Unit15	Concept of Social Enterprise and Social Entrepreneurship, Social Entrepreneurs, Sustainability Issues in Social Entrepreneurship, Rural Entrepreneurship, Family Business		
Unit16	Entrepreneurship, Concepts of Entrepreneurship Failure, Issues of Entrepreneurial failure, Fading of Entrepreneurial success among once leading corporate groups		
Unit 17	Entrepreneurial resurgence, Reasons of Entrepreneurial Failure, Essentials to Avoid Unsuccessful Entrepreneurship		
Block 5	PROJECT MANAGEMENT AND EVALUATION		
Unit 18	Forms of Business Ownership, Issues in selecting forms of ownership		

Unit 19	Environmental Analysis, Identifying problems and opportunities, Defining Business Idea, Planning Business Process
Unit 20	Project Management: Concept, Features, Classification of projects, Issues in Project Management, Project Identification, Project Formulation, Project Design and Network Analysis
Unit 21	Project Evaluation, Project Appraisal, Project Report Preparation, Specimen of a Project Report
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. C.R. Kothari, Gaurav Garg. Research Methodology: Methods and Techniques, New Age International Publishers, 2019. 2. Kumar. R: Research Methodology: A Step-by-Step Guide for Beginners, (3rd Edition), SAGE, Inc., 2011. 3. https://onlinecourses.swayam2.ac.in/cec22_ge28/preview 	

Programme: M.Sc.	Year: 2023-24	Semester: III
Subject: Environmental Science		
Course Code: PGEVS-111N	Course Title: Water Quality and Water Treatment Technology	
Course Objectives: <ul style="list-style-type: none">To discuss the properties of water and water quality estimationTo discuss the wastewater treatment and managementTo discuss the various methods of waste water treatment		
Course Outcomes: <ul style="list-style-type: none">CO 1: Able to know the physiochemical properties of waterCO 2: Able to know characteristics of waste water, sewage and sludge.CO 3: Learn to preliminary, secondary treatment process of waste waterCO 4: learn about methodology of ion exchange and disinfection for waste waterCO 5: Also known the water born disease and water acts		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Water Properties and Wastewater	
Unit I	Properties of Water: Structure of water molecule, chemical composition of water, chemical bonding in water unique properties of water, water on earth, water cycle, water as solvent, scarcity of water in India.	
Unit II	Water Quality Estimation: Water quality index, water quality standard in India, physiochemical properties of water, pH, Dissolve oxygen (DO), Chemical Oxygen Demand (COD), biological oxygen demand (BOD, Total Dissolve solid (TDS), turbidity, nitrate, sulphate and	

	chloride.
Unit III	Wastewater, Sludges and Sewage: Definition of wastewater and sludges, domestic wastewater, industrial wastewater, activated sludge, characteristics and quantities of waste sludges, physical, chemical & biological characteristics of sewage, criteria for selection of site for sewage treatment plant.
Block 2	Sewage Treatment:
Unit IV	Preliminary Treatment: Screenings, sedimentation, Grit chamber, and Skimming tanks, primary treatment- primary sedimentation – description & working.
Unit V	Secondary Treatment: Activated sludge, sludge process, trickling filters, natural biological treatment systems, wastewater stabilization ponds, anaerobic ponds, facultative ponds, anaerobic ponds, contact beds.
Unit VI	Low Cost Waste Treatment: Oxidation ponds, Oxidation ditches, Activated Lagoon, Anaerobic lagoons and Septic tank.
Block 3	Wastewater Treatment
Unit VII	Coagulation and Precipitation: Coagulation- flocculation, primary coagulants, type of coagulants, mechanism of coagulation, coagulation control test, precipitation, metals removal, removal of fats, oils and greases.
Unit VIII	Filtration: Filtration, slow sand filter, rapid sand filter types of filtration, vacuum filtration, membrane filtration, types of membranes.
Unit IX	Ion Exchange and Disinfection of Water: Ion exchange, types of ion exchangers, natural ion exchange, synthetic ion exchangers, cation-exchange resins, disinfection of water - methods of disinfection – chlorination.
Block 4	Water Resource and Management
Unit X	Water Quality and its Management: Drinking water quality and water quality standard, agencies for setting water quality standards, need for management of water quality, factors affecting water quality, steps for water quality management, surface and ground water quality.
Unit XI	Waterborne Diseases: Define waterborne disease, name and characteristics of waterborne diseases, symptoms of water born disease, prevention and treatment of waterborne diseases.
Unit XII	Water Acts: Water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975, Environment protection issues and problems, international & national efforts for environment protection.
Suggested Text Book Readings:	
<ol style="list-style-type: none"> 1. Environmental Science, Subhas Chandra Santra, new central book agency, 3rd Edition, 2011 2. Water & Waste Water Technology, Hammer M.J. & Hammer, Jr. M.J. , Prentice Hall of India Pvt Ltd New Delhi. 3. Waste Water Engineering, Treatment. Disposal & reuse, Metcalf & Eddy, McGraw 4. Water pollution, Rico D.P.S, IX, WIT Press UK 5. Principles of water quality management, Eckenfelder 	

Suggested online links
<ol style="list-style-type: none"> 1. Properties of Water: Ch3-4Water&O-Chem.ppt (sdsu.edu) 2. Properties of Water: properties-of-water-worksheet (baymeadowscharter.org) 3. Water Quality Analysis Laboratory Methods: Microsoft PowerPoint - LSD-NEERI-Water Quality Analysis (mpcb.gov.in) 4. Water Quality Assessment And Monitoring: Water.pdf (iitk.ac.in) 5. Water Quality Standards: Microsoft Word - CHE_P4_M8_e-Text.docx (inlibnet.ac.in) 6. Wastewater Treatment Processes: Microsoft PowerPoint - Sep12 WW [Compatibility Mode] (iitd.ac.in)
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer:
Wastewater Treatment and Recycling: https://onlinecourses.nptel.ac.in/noc19_ce32/preview

Programme: M.Sc.	Year: 2023-24	Semester: III
Subject: Environmental Science		
Course Code: PGEVS-112N	Course Title: Remote Sensing and GIS	
Course Objectives: <ul style="list-style-type: none">To discuss the concept of remote sensing and image interpretationTo discuss the atmospheric window source of energy for remote sensingTo discuss about platform, sensor and application of remote sensingTo discuss the concept of global position system and its components		
Course Outcomes: <ul style="list-style-type: none">CO 1: Learn about concept of remote sensingCO 2: Able to know electromagnetic radiation and its role in remote sensing.CO 3: Learn about device like platform, satellite and sensor used in remote sensingCO 4: Able to know image interpretation and data processingCO 5: Also learn about GIS and its handling		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Remote Sensing and Image interpretation	
Unit I	Concept of remote sensing: History, concept and principle of remote sensing, process and characteristics of remote sensing system, element of remote sensing, types of remote sensing, advantages and limitations.	
Unit II	Concept of Electromagnetic Radiation (EMR): EM radiation and EM spectrum, laws of radiation, energy interactions with the	

	earth surface features, concept of spectral signatures.
Unit III	Image Interpretation: Characteristics of remote sensing data; preprocessing; Enhancements, Classification, data acquisition and interpretation,
Block 2	Aerial photographs and Sensor:
Unit IV	Data Processing: Image acquisition and processing, image classification, elements of photo and imagery pattern and interpretation-drainage, erosion, details, gray tones, and applications of digital image processing.
Unit VIII	Aerial Photographs Basic concepts– types, scale, resolution of aerial photography; properties of aerial photos, applications of aerial photography.
Unit V	Sensor: Sensor system, types of sensors, imaging and non-imaging sensors, active and passive sensors, resolution of sensors - spectral, spatial, radiometric & temporal, scale, mapping unit.
Block 3	Platforms, Satellites and Application of Remote Sensing:
Unit VI	Platforms Types and their characteristics of platforms, ground, airborne and space borne platforms.
Unit VII	Satellites and Orbits Satellites, types of satellites, satellites and their characteristics, meteorological satellites, types of orbits, orbital characteristics–coverage, passes, pointing accuracy.
Unit IX	Application of Remote Sensing: Application of remote sensing in atmospheric, hydrosphere, environmental, oceanographic, agriculture and urban planning studies.
Block 4	Global Information System
Unit X	Basic Concepts: Definition of GIS, components of GIS, variables-points, lines, polygon, functionality of GIS, areas of GIS application, advantage and limitation of GIS.
Unit XI	GIS Data: Spatial and attribute data, information organization and data structures - raster and vector data structures, data file and database.
Unit XII	GIS Software and map scale: GIS and remote sensing software, projection systems, categories of maps, map scales.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. M. Anji Reddy, Text Book of Remote Sensing and Geographical Information Systems, Publications/BSP Books-2012. 2. Kali Charan Sahu, Textbook of Remote Sensing and Geographical Information Systems, Atlantic Publishers and Distributors (P) Ltd-2023. 3. K. Subramanya, Engineering Hydrology, McGraw Hill Education, 2017. 4. Joseph, G., 2003. Fundamentals of Remote Sensing, University press. 5. Jensen, J. R. Introductory digital image processing a remote sensing perspective, Prentice Hall series in geographic information science. Suggested online links: <ol style="list-style-type: none"> 1. Introduction to Remote Sensing: Introduction To Remote.pdf 2. Basic Concepts Of Remote Sensing: Remote Sensing (nptel.ac.in) 3. Basic Concepts Of Remote Sensing Microsoft PowerPoint - Lecture 4 Remote Sensing 	

Introduction to GIS _Atta [Compatibility Mode] (uop.edu.pk) 4. Global Information System: ACKNOWLEDGEMENT (lsp4you.com) 5. Introduction to GPS: Data Model in GIS Data Model in GIS e.pathshala By SudoorSamved RS.GIS Facebook
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer: complete both course 1. Basics of Remote Sensing, Geographical Information System (GIS) and Global Navigation Satellite System (GNSS): Basics of Remote Sensing, Geographical Information System (GIS) and Global Navigation Satellite System (GNSS) - Course (swayam2.ac.in) 2. Remote Sensing Essentials: Free Online Course: Remote Sensing Essentials from Swayam Class Central

Programme: M.Sc.	Year: 2023-24	Semester: III
Subject: Environmental Science		
Course Code: PGEVS-113N	Course Title: Plant Stress and Physiology	
Course Objectives: <ul style="list-style-type: none">• To discuss about plant physiology• To discuss different types plant stress• To discuss about plant minerals and plant growth hormones• To discuss about nitrogen fixation and carbon assimilation		
Course Outcomes: <ul style="list-style-type: none">• CO 1: Able know about plant stress and their physiology• CO 2: Learn about water, salinity and metal stress in plant• CO 3: Able to know about plant cell and transportation system in plant• CO 4: Learn the process of photosynthesis and carbon assimilation• CO 5: Also know the role of nitrogen in plant and it assimilation in plant		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Drought and Heat Stress	
Unit I	Introduction of Plant Stress: Stress, types of stress, classification of different kinds of abiotic stresses, interactions between biotic and abiotic stresses, stress proteins.	
Unit II	Drought and Water Deficit Stress: Morphological and physiological responses to drought, drought resistance mechanisms: escape and dehydration postponement, signal perception and signal transduction in drought stress dehydration tolerance, water loss from	

	plants-driving force for transportation, evapotranspiration.
Unit III	Heat Stress: Heat wave tolerance mechanism's role of membrane lipids in high temperature tolerance. Chilling and freezing stress, frost and cold injury effects on physiological process, crucial role of membrane lipid, heat shock protein (HSPs).
Block 2	Salinity Stress and Stress Protein
Unit IV	Salinity Stress: Alkalinity and salinity, Salinity effects at cellular and whole plant level, effects of salinity on growth, yield and some physiological processes of crop plants, molecular mechanism of salt tolerance, salt stress perception and signal transduction, compatible solutes and osmotic adjustment.
Unit V	Metal Stress: Aluminum and cadmium toxicity, physiological processes affected by aluminum and cadmium, alleviation of heavy metal stress by various technologies, role of phytochelatins.
Unit VI	Reactive Oxygen Species (ROS): Generation of ROS in plants-Fenton reaction and Haber-Weiss reaction, stress signaling molecules, relative oxygen species (ROS), role of scavenging systems (SOD catalase etc.).
Block 3	Plant Growth Regulator and Minerals
Unit VII	Plant Cell and Transportation: Plant cell, absorption and transportation of water, properties of solution, permeability, imbibition's, osmosis, ascent of sap.
Unit VIII	Plant Growth Regulator: Phytohormones and its effect on plant growth and development, regulation of plant morphogenetic processes by light, applications of plant growth hormones in agriculture.
Unit IX	Plant Minerals: Minerals elements in plants, types of plant nutrients, classification of mineral nutrients, availability of micro and macronutrients, essential and non essential nutrients, deficiency diseases of minerals elements in plants.
Block 4	Nitrogen Fixation and Carbon Assimilation
Unit X	Nitrogen Fixation and Assimilation: Biological nitrogen fixation by free living and in symbiotic association, structure and function of enzyme nitrogenase, assimilation of nitrate, assimilation of ammonia into organic compounds.
Unit X	Photosynthesis: Chloroplast structure, photosynthetic apparatus, , pigment structure and function, photochemical reaction, mechanisms of ATP synthesis, electron transport chain.
Unit XII	Carbon Assimilation: CO ₂ fixation and reduction in Calvin cycle, CO ₂ fixation in C ₄ plants; CO ₂ fixation in CAM plants and its significance, difference among C ₃ , C ₄ and CAM plants, photorespiration, effect of environmental factors on photosynthetic rates.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. A Textbook of Plant Physiology, Biochemistry and Biotechnology, S K Verma, Mohit Verma, S Chand Publication. 2. Fundamentals of Plant Physiology, by V. K. Jain , S Chand Publication. 3. Introduction to Plant Physiology, Norman P. A. Hüner ,William G. Hopkins, Wiley 	

publication, 2008.

4. Physiochemical and Environmental Plant Physiology, Fourth Edition, P. S, Nobel, Academic Press
5. Plant Growth and Development: Hormones and Environment. Srivastava, L. M, Academic Press, USA.

Suggested online links:

1. The Stress Concept in Plants: An Introduction: [The Stress Concept in Plants: An Introduction \(usp.br\)](#)
2. Reactive oxygen species in plants: Their generation, signal transduction, and scavenging mechanisms: [Reactiveoxygenspeciesinplants_theirgenerationsignaltransductionandscavengingmechanisms.pdf](#)
3. An Introduction to Reactive Oxygen Species: [ROS White Paper 2015.pdf \(biotek.com\)](#)
4. Plant Growth Regulators: [Plant Growth Regulators: Their Use in Crop Production \(iastate.edu\)](#)
5. Nitrogen assimilation: [Slide 1 \(dducollegedu.ac.in\)](#)

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: Basics in Research		
Programme: M.Sc./M.A.	Year: II	Semester: III
Subject: Statistics		
Course Code: <i>PGRT-03</i>		Course Title: <i>Basics Research Tools</i>
Course Objectives: The main objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of basic computer tools, research tools, indexing of research paper and scientific report writing.		
Course Outcomes: CO1: To know about the research tools and indexing of a research paper. CO2: To know about the fundamentals of basic computer tools and how to use it in research. CO3: Able to know the writing the research paper and scientific report writing.		
Credits: 4		Type of Course: Core
Max. Marks: 100		Min. Passing Marks: 36
Block 1	Introduction	
Unit 1	MEASURES OF CENTRAL TENDENCY MEASURES: Introduction, Definition. Objectives of Average .Characteristics of Good Average . Types of Average. Arithmetic Mean. Weighted Arithmetic Average .Median .Mode .Geometric Mean .Harmonic Mean	
Unit 2	MEASURES OF DISPERSION: Introduction. Definition .Objectives of Measuring Dispersion. Different Measures of Dispersion. Range .Standard Deviation . Lorenz Curve . Skewness . Kurtosis	
Block 2	PROBABILITY	
Unit 3	PROBABILITY – 1: Introduction . Meaning and Definition of Probability.	

	Probability Defined. Experiment. Sample Space (S). Event. Types of events in probability. Probability Measure. Probability Rules:. Probability Theorems. Addition Theorem. Multiplication Theorem
Unit 4	PROBABILITY 2: Conditional Theory. Key Concepts of conditional theory. Applications of conditional theory . Bayes' Theorem. Application of Bayes' Theorem. . Theoretical distribution . Uses of Theoretical Distributions. Types of Theoretical Distributions. Benefits Of Theoretical Distributions. Introduction. Binomial Distribution in Statistics . What Is The Binomial Distribution Formula?. Assumption For Binomial Distribution . Common Applications of Binomial Distribution. Poisson Distribution. Key Characteristics of Poisson distribution. Probability Mass Function (PMF). Applications of Poisson distribution. Assumptions of Poisson distribution. Common Uses of Poisson distribution. How to Solve Problems of Poisson distribution?
Unit 5	PROBABILITY 3: Introduction;. Binomial Distribution in Statistics . What Is The Binomial Distribution Formula?. Assumption For Binomial Distribution . Common Applications of Binomial Distribution. Poisson Distribution, Key Characteristics of Poisson distribution, Probability Mass Function (PMF), Applications of Poisson distribution, Assumptions of Poisson distribution, Common Uses of Poisson distribution, How to Solve Problems of Poisson distribution?, Introduction, Key Characteristics of Normal Distribution, Properties of Normal Distribution, Application of Normal Distribution, Types of Normal Distribution
Block 3	SAMPLING
Unit 6	SAMPLING: Introduction: Meaning of Sampling, Need of Sampling, Advantages of Sampling, Limitations of Sampling
Unit 7	SAMPLING METHODS OF DATA COLLECTION: Sampling, Data Collection, Methods For Collecting Statistical Data , Types Of Data, Primary And Secondary Data, Primary Data, Secondary Data
Unit 8	SAMPLING DISTRIBUTION: Probability and Non-Probability Sampling, Sampling Techniques, Probability or Random Sampling, Simple Random Sampling, Stratified Sampling , Systematic Sampling , Cluster Sampling, Area Sampling, Probability-proportional-to-size sampling, Double Sampling and Multiphase Sampling, Non-probability or Non Random Sampling, Quota sampling, Convenience or Accidental sampling, Purposive (or judgment) Sampling, Snow-ball Sampling
Unit 9	SOURCES OF DATA COLLECTION: Introduction: Meaning and Importance of Data, Primary Sources of Data, Advantages of Primary Data, Disadvantages of Primary Data, Methods of Collecting Primary Data, Secondary Sources of Data, Features and Uses of Secondary Data, Advantages of Secondary Data, Disadvantages of Secondary Data, Methods of Collecting Secondary Data, Difference between Primary Data and Secondary Data, Questionnaire and Schedule Construction, Basic Rules for Questionnaire Item Construction
Block 4	STATISTICAL INVESTIGATION AND ESTIMATION
Unit 10	STATISTICAL ESTIMATION: Introduction, Point estimation , Types of point estimators , Properties of point estimator, Point estimation methods , Advantages of Point estimation:, Disadvantages of Point estimation , Errors in Point Estimation, Uses of Point Estimation , Interval estimation Types of Interval estimation, Properties of Interval estimation, Interval estimation methods , Advantages of Interval estimation, Disadvantages of Interval estimation, Errors in Interval estimation, Uses of Interval estimation
Unit 11	SAMPLING TEST: Introductions , Types of Sampling , Sampling Methods, Sampling Test Statistics: Hypothesis Testing:, Common Sampling Tests, Large sample, Benefits

	of Large sample, Limitation of Large Sample , Test for large sample , Some specific tests for large samples include , Small Sample , Benefits of Small Sample, Limitations of Small Sample, Types of Small Sample , Test For Small Sample
Unit 12	HYPOTHESIS TESTING: Introduction or Conceptual Framework of Hypothesis, Uses of Hypothesis, Scientific Hypothesis, Measures of Hypothesis, Statistical Hypothesis testing, Hypothesis Error
Unit 13	NON PARAMETRIC TEST: Non parametric test, Wilcoxon rank-sum test (Mann-Whitney U test), The Wilcoxon signed-rank test, The Kruskal-Wallis H test, Spearman's rank correlation, Chi-square test
Block 5	Statistical Tools
Unit 14	CORRELATION AND REGRESSION: Introduction, Definitions, Types of Correlation, Methods of Determining Correlation, Calculation of Coefficient of Correlation, Rank Correlation, Regression, Utility of Regression, Methods of Studying Regression, Regression Equation, Comparison of Correlation and Regression
Unit 15	STATISTICAL QUALITY CONTROL (SQC): Introduction, Key components of SQC, Benefits of SQC, Uses of SQC, Limitations of Statistical Quality Control, Functions of Statistical Quality Control
Unit 16	CONSTRUCTION OF CONTROL CHARTS: Introduction to Control Charts, Key Components of a Control Chart, How Control Charts Work, Types of Control Charts, Construction of Control Charts, Formula to calculate control chart, Control Chart Constants
Unit 17	CHI SQUARE TEST: Introduction, Chi-Square as Non-Parametric Test, Test of Goodness of Fit

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-116N	Course Title: Geosciences and Natural Resource Management	
Course Objectives: <ul style="list-style-type: none">• To discuss the geological process and their role in understanding the earth structure.• To discuss the geochemical cycle and biogeochemical factor in environmental health• To discuss the natural hazardous and disaster management• To discuss the natural resource and approach to resource management		
Course Outcomes: CO 1: Learn about earth surface process and landscape CO 2: Able to know geochemistry of earth system CO 3: Lean about types of disaster and their assessment and vulnerability CO 4: Able to do natural resources management CO 5: learn about ecological, social and economic dimension of natural resources		
Credits: 4	Type of Course: Core	

Max. Marks: 100		Min. Passing Marks: 36
Block 1	Environmental Geosciences	
Unit I	Earth Surface Process and Biosphere: Conservation of matter in various geospheres- lithosphere, hydrosphere atmosphere and biosphere, geological processes and their role in understanding Earth structure, Plate Tectonics, General relationship between landscape, biomes and climate	
Unit II	Environmental Geochemistry: Concept of major, trace and REE (Rare Earth Element), classification of trace elements, mobility of trace elements, geochemical cycles, biogeochemical factors in environmental health, possible effects of imbalance of some trace elements.	
Unit III	Natural Hazards and Disaster: Hazard and disaster, study of floods, landslides, earthquakes, volcanism and avalanche, dimensions of disaster, classification of natural hazards, natural hazards and human intervention, hazard assessment, vulnerability, catastrophic geological hazards.	
Block 2	Natural Resource-I	
Unit IV	Introduction to Natural Resource: Concept of resource, classification of natural resources, factors influencing resource availability, distribution and uses, ecological, social and economic dimension of resource management, interrelationships among different types of natural resources.	
Unit V	Soil Resources: Soil profile, soil characteristic, soil organic matter and humus, soil conservation and erosion, methods of soil conservation, desertification, land as a resource, integrated land use planning, land use classification, land degradation.	
Unit VI	Forest Resources: Natural and manmade forest, forest cover, major forest types and their characteristics, deforestation, Afforestation desertification, forest conservation, social forestry, reserved forest, protected forest, national forest policy 1952, forest conservation act, 1980, forest rights act, amendment rules 2012.	
Block 3	Natural Resource-I I	
Unit VII	Food Security Resources: National and international food, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, security.	
Unit VIII	Fish and Marine Resources: Production, status, dependence on fish resource, unsustainable harvesting, issues and challenges for resource supply, new prospects.	
Unit IX	Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, use and exploitation of petroleum, coal and natural gas.	
Block 4	Natural Resource and Management	
Unit X	Mineral Resources: Use and exploitation, minerals and its physical properties, classification of mineral, weathering and mineral formation, environmental effects of extracting and using mineral resources, case studies.	
Unit X	Water Resources: Groundwater and aquifer, surface water, stream water, watershed, estuaries, flood plain and wetland, integrated water management system, rainwater harvesting, dams-benefits and problem.	
Unit XII	Approaches in Resource Management: Ecological approach, economic approach; ethnological approach, implications	

	of the approaches, integrated resource management strategies. Poverty and implications in resource management in developing countries, resource extraction and control system.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Sustainable Natural Resource Management: For Scientists and Engineers, D. R. Lynch, Publisher: Cambridge University Press. 2. Concepts of Environmental Management for Sustainable Development Publisher, M.C. Dash, I K International Publishing House Pvt. Ltd. 3. Environmental Geology: An Earth Systems Approach, Dorothy Merits, W.H. Freeman-2014 4. Environmental Geography, Savindra Singh,” Pravalika Publications-2019 5. Natural Resources Conservation & Management , K. K. Singh, M D Publications Pvt. Ltd Suggested online links: <ol style="list-style-type: none"> 1. Earth’s structure: untitled (deakin.edu.au) 2. Surface Processes: Surface Process (eolss.net) 3. Elements Of Geology: geologic processes on earth.pdf (nist.gov) 4. Geologic Processes On Earth: PowerPoint Presentation (nist.gov) 5. Climate Zones and Biomes: Year 3 Unit 4 Biomes workbook 0.pdf (arkconway.org) 6. The Major Biomes: biomesummarylpa_rev (d43fweuh3sg51.cloudfront.net) 7. Natural Resource Management: B (worldbank.org) Natural Resources: Chapter2.p65 (ugc.ac.in)	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer:	
1. Natural Resources Management: Natural Resources Management - Course (nptel.ac.in)	

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-117N	Course Title: Atmosphere and Ocean science	
Course Objectives: <ul style="list-style-type: none">• To discuss the origin of the universe• To discuss the physical and structural components of atmosphere• To discuss the chemistry of aerosol and photochemical• To discuss the heat budget and ocean process and their interaction with land		
Course Outcomes: <p>CO 1: Able to understanding the origin of universe and their characteristic.</p> <p>CO 2: Learn chemistry of atmosphere like aerosol and photochemistry</p> <p>CO 3: Able discuss heat and water budget of ocean and circulation of Indian ocean</p> <p>CO 4: Learn the characteristics, role and phenomenon of waves and tides.</p> <p>CO 5: Also Understand the global effects of ENSO, causes of the irregularity of ENSO</p>		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	

Block 1	Atmosphere: Structure and Properties
Unit I	Origin of the Universe: Universe and its space and atmosphere, characteristics of deep space environment, atmospheric window and energy flow in atmosphere, heat budget, earth's atmosphere and its significance, measures of water vapor in the atmosphere
Unit II	Atmospheric Structure: Structure of atmosphere based on vertical temperature profile, gaseous composition and atmosphere based on gaseous composition, temperature stratification and ozone layer.
Unit III	Physics of atmosphere Vertical thermal structure and composition of the atmosphere, Temperature, variation of temperature, virtual temperature, density, variation of density, pressure and humidity, humidity parameters, thermodynamic properties of dry air - adiabatic temperature change, gas laws and their application to the atmosphere, atmospheric instability and convection-stability criteria.
Block 2	Atmosphere: Chemistry and Lapse Rate
Unit IV	Atmospheric photochemistry: Chemical composition of the earth atmosphere, vertical profiles of major and trace gases, atmospheric photochemistry, reaction of nitrogen, oxygen, ozone, chlorides, Photochemical reactions in atmosphere smog formation and effects on environment.
Unit V	Aerosols Chemistry Concept of aerosols, types of aerosol particles, formation and growth of aerosol, lifecycle of aerosol, methods of observations of aerosol, atmospheric aerosol and climate.
Unit VI	Atmospheric Stability: Concept of lapse rate, atmospheric stability of lapse rate, types of lapse rate, vertical displacement of air, stable atmosphere and unstable atmosphere, turbulent dispersion.
Block 3	Fundamentals of Oceanography
Unit VII	Introduction and water budget of ocean: Physical properties of sea water; distribution of temperature, salinity, density and oxygen in space and time; acoustical and optical characteristics of seawater, identification of water masses, water masses diagrams, water masses of the Atlantic, Pacific, and Indian, Ocean.
Unit VIII	Heat budget of Ocean: Insulations, long wave radiation, effect of clouds, sensible and latent heat transfer, Bowen ratio, ocean heat transport, spatio-temporal variability of heat budget terms and net heat balance.
Unit IX	Ocean Waves and Tides: Characteristics, shallow water transformation and breaking, long-shore and cross-shore currents; rip currents, tide generation and propagation, characteristics of tides, tidal current spring and neap tides, diurnal and semi-diurnal tides.
Block 4	Ocean process
Unit X	Ocean-Atmosphere Interaction: Extra-tropical ocean-atmosphere interaction, north Atlantic oscillation, physics of El Nino, La Nina and southern oscillation; global effects of ENSO, causes of the irregularity of ENSO, ENSO teleconnections.
Unit XI	Ocean-Atmosphere Interface: Tropical atmosphere-ocean coupling, effect of wind stress, sea surface temperature and fluxes of heat, moisture and momentum, structure and composition of the coastal

	atmosphere, dynamics of the exchange of heat, moisture and momentum at the ocean-atmosphere interface.
Unit XII	Indian Ocean Circulation: Ocean surface circulation, equatorial current systems, upwelling and sinking, wind-driven currents in the oceans, northeast and southwest monsoon winds, winter cooling and convection, Indo-Pacific ocean warm pool, circulation in Arabian sea and bay of Bengal, Pacific-Indian ocean exchange.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Dynamics of Ocean and Atmosphere, Gill A., Academic Press 2. Atmosphere, Ocean and Climate Dynamics: An Introductory Text, John Marshall, Academic Press. 3. An Introduction to Dynamical Meteorology, Holton J R, Academic Press 4. Descriptive physical oceanography: an introduction, Lynne D. Talley, Academic Press 5. Principles of Ocean Physics, John Ralph Apel, Academic Pres 	
Suggested online link: <ol style="list-style-type: none"> 1. Origin of the Universe: Chapter4.pdf (uu.edu) 2. Composition and structure of atmosphere: Microsoft PowerPoint - Chapter.1.composition (uci.edu) 3. Photochemistry of The Earth's Atmosphere: Microsoft PowerPoint - rodriguez seminar 6 28.pptx (nasa.gov) 4. Introduction to Physical Oceanography: por Robert H Stewart.pdf (uv.es) 5. Basic Concepts in Oceanography: 32034841.pdf (iaea.org) 	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: <ol style="list-style-type: none"> 1. Introduction to atmospheric Science: NPTEL: Atmospheric Science - Introduction to Atmospheric Science 	

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-118N	Course Title: Environmental Impact Assessment and Management	
Course Objectives: <ul style="list-style-type: none">• To discuss the basic Concept of EIA and its methodology• To discuss the types, process and significance of environmental audit• To about scope, strategy, tools and goals of environmental management• To discuss the strategy of environmental planning and polices		
Course Outcomes: CO 1: Able to know history and scope of environmental impact assessment CO 2: Learn EIA methodology and their significance CO 3: Learn how to EIA filing and take environmental clearance CO 4: able to work on the EIA notification. CO 5: Able to know the concept of environmental planning and sustainable development.		
Credits: 4	Type of Course: Core	

Max. Marks: 100		Min. Passing Marks: 36
Block 1	EIA and its Methodology	
Unit I	Basic Concept of EIA: Introduction of EIA, evolution and history of EIA, objective of EIA, EIA-Short-term and Long-term objectives, origin and development of EIA in India, Initial environmental Examination, preparation of Environmental Base map.	
Unit II	Process of EIA: Principle of EIA, steps in EIA process-project screening, scoping, baseline data collection, impacts identification, impact prediction and alternative, mitigation measures, EIA Report preparation, Public hearing, decision making, implementation and follow-up.	
Unit III	Components of EIA: Comprehensive and rapid EIA, air environment, environmental monitoring of noise environment, water environment, biological environment, land environment, socio-economic and health environment, risk assessment.	
Block 2	EIA Methodologies and Notification	
Unit IV	Environmental Impact Statement (EIS): Concept of environmental impact statement, draft statement, impact assessment methodology, Statement documentation, general writing suggestion, and environmental assessment plan (EMP), role and nature of participant involved in EIA.	
Unit V	E I A Methodologies: Introduction, criteria for the selection of EIA methodology, methods of EIA, Ad-hoc methods, matrix methods, network method, environmental media quality index method, overlay method, Cost/benefit analysis – EIS and EMP.	
Unit VI	EIA Notification and Guidelines: EIA notification by ministry of environment and forest (Government of India), procedure for environmental clearance, procedure for conducting environmental impact assessment report, evaluation of EIA report, EIA guidelines 2006.	
Block 3	Environmental Audit	
Unit VII	Introduction to Environmental Audit: Concept of environmental auditing, objective of environmental audit, type of environmental audit, principal area of environmental audit, feature of environmental audit, setting up audit program-scope and frequency of audit, environmental audit committee, the audit protocol, advantages of environmental audit.	
Unit VIII	Environmental Audit Activity: Introduction and scope of environmental auditing, pre-audit activity, activity at site, post audit activity, carrying out the audit-collection information, audit interview, documentation, public disclosure, benefits of environmental audit.	
Unit IX	Environmental Auditing Report (EAR): Preparation of draft report, contents of report, facts and finding of audit, ISO14000 requirements of rule 14 for environmental audit under environmental protection act of 1986.	
Block-4	Environmental Management	
Unit X	Environmental Management: Objective and scope of environmental management, strategy of environmental management, goals of environmental management, tools of environmental management, general scheme of environmental management, environmental management system, framework of environmental management system, BS77560 and ISO 14001.	
Unit XI	Environmental Planning: Evolution and history of environmental planning, environmental concern in urban	

	settlement, development of habitat patterns, environmental approaches to design and planning of rural settlements, use of alternate technology in design of human settlements, conservation aspects of built-up areas, green belt design.
Unit XII	Environmental Policy and Sustainable Development: Environmental Protection Act 1986, National conservation strategy and policy statement on environment and development 1992, National Environmental Policy 2006, vision statement of environment and health, world commission of environment and development, UN conference on human environment, sustainable development, sustainability and development indicators, carrying capacity.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Impact Assessment: Theory and Practice, PWathern, Routledge Publishers, 2. Environmental Impact Assessment: A Practical Guide, BMarriott, McGraw-Hill Publication, 3. Environmental Impact Assessment, Srivastava A.K., et al.,APH Publishers 4. Environmental Impact Assessment Methodologies, Anjaneyulu Y. et al., CRC Press 5. Introduction to EIA, Glasson J., TherivelRiki, Chadwick Andrew, Oxford Brookes University. Suggested online links: <ol style="list-style-type: none"> 1. EIA Methodologies: UNIT-2.pdf (khitguntur.ac.in) 2. Components of EIA: envis.org - Components of EIA 3. Environmental Auditing: Microsoft PowerPoint - Environmental Auditing [Compatibility Mode] (cseindia.org) 4. Environmental Management and Planning: Concept types and importance of environm.pdf 5. Environmental Management and Sustainable Development: E4F82602 (ifad.org) 	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: Environmental Impact Assessment: Taught by Prof. Harshit Sosan Lakra, Free Online Course: Environmental Impact Assessment from Swayam Class Central	

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-120N	Course Title: Environmental Toxicology & Occupational Health Hazards	
Course Objectives: <ul style="list-style-type: none">• To discuss about environmental toxicity and toxicant• To discuss about rout of environmental toxicant of human beings• To discuss about occupational toxicology and its effects on human health• To discuss the transformation of toxicant and systematic toxicity		
Course Outcomes: <p>CO 1: Able to know the toxicity of environment and its effect</p> <p>CO 2: Learn the duration and exposure of toxicant.</p> <p>CO 3: Able to know the distribution, binding and storage, and excretion of toxicant.</p> <p>CO 4: Know the different types of systematic toxicity.</p> <p>CO 5: Also learn the occupational toxicant exposure and limits</p>		

Credits: 4		Type of Course: Core
Max. Marks: 100		Min. Passing Marks: 36
Block 1	Toxicity and Toxicants	
Unit I	Introduction to Toxicology: Definition, history and scope of toxicology, toxicant, types of toxicant, toxicity and toxic agent, factor effects toxicants, target and non organ toxicity, dose effects and dose response relationship.	
Unit II	Toxicants: Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins.	
Unit III	Duration and exposure of toxicant: Acute exposure, chronic exposure, types of human exposure- internal exposure, occupational exposure, environmental exposure, accidental poisoning and internal poisoning	
Block 2	Toxicity and Public Health	
Unit IV	Fate of toxicant in human body: Toxicant absorption, distribution, binding and storage, and excretion, active and passive transport of toxicant.	
Unit V	Chemical toxicity in human: Alcohol toxicity, toxicity of ketones, minerals toxicity-sodium, potassium, iodine, iron, nitrogen, calcium, zinc, copper, selenium and manganese toxicity, toxicity of dioxins.	
Unit VI	Public Health: Toxicologists and public health, laws and regulations governing toxicants, epidemiological approaches to toxicants, Blacklisted toxic chemicals, pesticide, automobile emission.	
Block 3	Systematic Toxicity	
Unit VII	Renal toxicity Renal toxicity- Renal structure and functions, susceptibility of kidney to toxic insult, chemically induced renal injury.	
Unit VIII	Cutaneous toxicology: Dermatological effects of toxic agents, Allergic contact dermatitis, Cutaneous carcinogenesis	
Unit IX	Pulmonary and Hepatic toxicity: Toxicant causing respiratory dysfunction, mechanism of entry of toxicant into the lungs, Systematic lung toxins, Actions of toxins on the liver, Chronic liver injury.	
	Carcinogenesis and Testing methods	
Unit X	Carcinogenesis and mutagenicity: Carcinogens and carcinogenesis, types of carcinogens, mechanism of carcinogenesis, Mutation and mutagenicity, types of mutation, mechanism of mutagenesis	
Unit XI	Transformation of toxicants: Bioaccumulation, biomagnifications, biotransformation, types of biotransformation, biotransformation of DDT, toxic material in environment.	
Unit XI	Occupational toxicology: Occupational toxicants, exposure limits, Risks associated with hazardous substances, Risk assessment and management guidelines, Occupational/Industrial hygiene, Hazard control.	
Suggested Text Book Readings:		

1. Environmental Toxicology, Kees van Gestel, Vrije University, Amsterdam, [Environmental Toxicology](#)
2. Environmental Toxicology, Third Edition, Sigmund F. Zakrzewski, oxford university press
3. A Textbook of Modern Toxicology: Ernest Hodgson A John Wiley & Sons, Inc., Publication
4. Principles of Environmental Toxicology, I. Shaw, J. Chadwick, CRC Press
5. Occupational Toxicology, Chris Winder, Neill H. Stacey, CRC Press

Suggested online links:

1. Introduction to Toxicology Introduction to Toxicology: [Introduction to toxicology \(europa.eu\)](#)
2. Chemical toxicology: [chemical toxicology part 2 || effects of heavy metals like arsenic | mercury, chromium, cadmium lead - youtube](#)
3. Drug-induced nephrotoxicity: <https://www.scielo.br/j/ramb/a/TC7wp7jkjgSjPMZ9ZNnqdMF/?lang=en&format=pdf>
4. Toxicology in Occupational and Environmental Setting: [c01 \(wiley-vch.de\)](#)

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-121N	Course Title: Biochemistry and Nanobiology	
Course Objectives: <ul style="list-style-type: none">• To discuss the environmental physiology• To discuss the chemistry of cell membrane and effects of environmental factor on cell membrane• To discuss the about enzyme and its role in human physiology• To discuss the nanotechnology and its application in environment		

Course Outcomes: CO 1: Able to understanding the biochemistry of altered membrane permeability. CO 2: Learn the concept of environmental physiology CO 3: Learn the biochemical approaches to the detoxification of xenobiotics CO 4: Learn the role of nanoscience, nanotechnology and nanobiology CO 5: Also know the environmental applications of nonmaterial	
Credits: 4	Type of Course: Core
Max. Marks: 100	Min. Passing Marks: 36
Block 1	Environmental physiology:
Unit I	Environmental physiology: Environmental physiology with considerations of intermediary metabolism-approaches for studying energy metabolism and body temperature changes; Thermo regulation and adaptation. Oxygen uptake from the environment, respiration and metabolism
Unit II	Biochemistry membrane: Biochemistry of altered membrane permeability, free radical formation, lipid peroxidation, lysosomal degradation, superoxide dismutase.
Unit III	Detoxification of xenobiotics: Biochemical approaches to the detoxification of xenobiotics through cellular metabolism, Environmental pollutants and their effects on living system.
Block 2	Respiration and Oxidative phosphorylation
Unit IV	Respiration: Types of respiration, Regulation of plant glycolysis, translocation of metabolites across mitochondrial membrane, TCA cycle.
Unit V	Oxidative phosphorylation: Mitochondria, electron transport chain-its organization and function, regulation of oxidative phosphorylation.
Unit VI	Metabolism of carbohydrates: Kreb's Cycle, electron transport system in mitochondria, oxidative phosphorylation and mechanism of ATP synthesis.
Block 3	Fundamentals of Enzyme
Unit VII	Introduction to Enzyme Enzyme and Enzymology, classification of enzyme, formation of enzyme, enzyme reaction, factor effecting on enzyme reaction.
Unit VIII	Enzymes mechanism: Types of mechanism enzymes, activation energy and transition state, enzyme catalyzed reactions, factors effecting the enzyme catalyzed reactions
Unit IX	Coenzymes and cofactors: General properties of enzymes, coenzyme and enzyme proteins, coenzymes involved in different metabolic pathways, phosphate and B ₁₂ coenzymes.
Block 4	Nanobiology
Unit X	Introduction to nanoscience: Definition of nanoscience, nanotechnology and nanobiology, diffusion in membranes and cells, interactions of biological systems with natural and engineered nanomaterials.
Unit X	Nanodots: Biological Applications-Quantum Devices- carbon nanotubes, nanoparticles in pharmaceutical and medicinal field, biomedical applications of nanoparticles, health risks of nanoparticles

Unit XII	Nanomaterials: Environmental applications, Zerovalent iron nanoparticles, titanium dioxide, silver nanoparticles - nanomembrane process; nanosorbants- mesoporous silica ground water remediation; nano technology based drinking water and waste water treatment.
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Physiology of Animals, Pat Willmer, Graham Stone, Ian Johnston, Blackwell Publishing 2. Biochemistry, Kevin Ahern, Indira Rajagopal, Oregon State University 3. Textbook of Biochemistry, Seema PavgiUpadhye, Dreamtech Press 4. Biochemistry, Satyanarayana, Elsevier 5. Introduction to Nanotechnology, Charles P Poole Jr., and Frank J. Ownes, John Wiley Sons, Inc., 2003. Suggested online links: <ol style="list-style-type: none"> 1. Environmental Physiology: 75907223.pdf (core.ac.uk) 2. Cell Membrane and Fluid Mosaic Model: Cell Membrane and Fluid Mosaic Model - YouTube 3. Biomembranes structure and function: Slide 1 (unizg.hr) 4. Electron Transport Chain (Oxidative Phosphorylation): Electron Transport Chain (Oxidative Phosphorylation) - YouTube 5. Introduction to Enzymes: ed8ad70c5da6e71f70db998dcc27987e.pdf (shivajicollege.ac.in) 6. Introduction to Enzymes: An Introduction to ENZYMES_122019-v6.pdf (worthington-biochem.com) 7. Nanomaterials: Chemistry Nanomaterials (gcekjr.ac.in) 	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Programme: M.Sc.	Year: 2023-24	Semester: IV
Subject: Environmental Science		
Course Code: PGEVS-122N	Course Title: Environmental Biotechnology and IPR	
Course Objectives: <ul style="list-style-type: none">• To discuss the biotechnological aspects on bioreactor and biofertilizers• To discuss the biotechnological aspects on bioremediation and bio-fuel• To discuss about laboratory and environmental biosafety• To discuss the bio-safety and intactual properties right		

Course Outcomes:	
CO 1: Able to know the scope of environmental biotechnology.	
CO 2: Learn the role of biotechnology in waste water treatment.	
CO 3: Able to know the role of biotechnology in bioreactor and biofertilizers	
CO 4: Learn the concept of bioremediation and phytoremediation.	
CO 5: Also learn about Intellectual properties, copyrights and trademarks in briefly	
Credits: 4	Type of Course: Core
Max. Marks: 100	Min. Passing Marks: 36
Block 1	Biotechnology for Bioreactors and Biofertilizers
Unit I	Environmental Biotechnology: Definition, scope and role of biotechnology in environment protection, Current Status of Biotechnology in Environment Protection, Future Biotechnology for air pollution abatement and odor control: Deodorization process - bioscrubbers, biobeds, Biotrickling filters
Unit II	Bioreactors for Waste: Water Treatment: biological processes for industrial treatment-aerobic biological treatments, activated sludge process, biological filters, rotating biological contactors (RBC), anaerobic biological treatment: contact digesters, packed column reactors, upflow anaerobic sludge reactor (UASB)
Unit III	Biofertilizers: Definition and types of biofertilizers, use of microbes as biofertilizers and bioinsecticides to improve productivity and crop protection, biopesticides: bacterial (bt pesticides), fungal (trichoderma), role of symbiotic and symbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (vam).
Block 2	Biotechnology for Bioremediation and Bio-filter
Unit IV	Bioremediation: Definition and types of bioremediation, bioremediation of contaminants, bioremediation strategy GMO for bioremediation, bioaugmentation, bioremediation of soil and water contaminated with oil spills, heavy metals and pesticides by soil microorganisms, advantage of bioremediation.
Unit V	Phytoremediation: Concept of phytoremediation, types of phytoremediation, hypo and hyper accumulating plants species, biotechnology in cleaning up the environment by plants, phytoremediation of heavy metal contaminated soils.
Unit VI	Bio-filter: Concept of bio-filter, types of biofilters, biofiltration media, biotransformation and transport process in biofilters, biofilter for pollutants removal, phytofiltration
Block 3	Biotechnology for Bioprocess technology
Unit VII	Bioprocess technology: Concept of fermentation, types of fermentation, scaling of fermentation process, application of microbes in industrial production of citric acid and alcohol, role of microbes in processing of various food products and food preservation.
Unit VIII	Biofuels technology: Role of microbes in energy production, biogas production (Methanogenic bacteria), microbial hydrogen production, ethyl alcohol production from sugarcane and single cell protein (SCP).
Unit IX	Biosensor technology: Concept of biosensor, ion-selective field effect transistor, thermal sensor, enzyme electrode, immobilized cell biosensor, DNA probe.
Block 4	Bio-safety and Intellectual Properties Right
Unit X	Introduction to Bio-safety: Bio-safety and risk assessment issues, regulatory framework, National biosafety

	policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety.
Unit XI	Laboratory and environmental biosafety: General principle of laboratory and environmental biosafety, Healthy aspects; toxicology, allergenicity, antibiotic resistance etc. Impact on environment; gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms.
Unit XII	IPR: Intellectual properties, copyrights, trademarks, trade secret, patents, geographical indications, etc.; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; convention on biological diversity
Suggested Text Book Readings: <ol style="list-style-type: none"> 1. Environmental Biotechnology, Principles and Applications by Bruce E Rittman and Perry L McCarty, McGrawhill Higher education. 2. Environmental Biotechnology: Theory and Application, Gareth M. Evans, Judith C. Furlong, University of Durham, UK and Taurus Biotech Ltd 3. Bioremediation and Natural Attenuation by Pedro J JAlvarage and Walter A Illman, Wiley Interscience. 4. Law and The Human Body; Property Rights, Ownership and Control, Hardcastel Rohan, Hart Publishing 5. Pharmaceutical Biotechnology and the Law, Cook M.Trevor, Lexis Nexis Suggested online links: <ol style="list-style-type: none"> 1. The Bioreactor – an Innovative Method of Disposal of Solid Waste: <u>The Bioreactor - an Innovative Method of Disposal .pdf</u> 2. Biofertilizers: <u>Lec 18 - Biofertilizers (eagri.org)</u> 3. Bioremediation: <u>BSc Chemistry (inflibnet.ac.in)</u> 4. Application of Biosensors in Environmental Monitoring and Recent Advances: <u>1511255447Paper15EMB Module26 PCBabitaKhosla etext.pdf (inflibnet.ac.in)</u> 	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer:NA	

Practical work

PGEVS-104N(P)	Practical's based on PGEVS-101N,102N and 103N
PGEVS -109N(P)	Practical's based on PGEVS-106N,107N and 108N
PGEVS-114N(P)	Practical's based on PGEVS 111N,112N and 113N
PGEVS -119N(P)	Lab work based on PGEVS -116N,117N and 118N
PGEVS -123N(P)	Lab work based on PGEVS -120N,121N and 122N
Note: The topic of practical will be selected form relevant theory paper as per suggestion of relevant faculty members of study centre.	

<p style="text-align: center;">PGEVS-124N(D) Dissertation/Industrial training/Internship with Viva Voce</p>
<p>Course Objective: Project and Dissertation</p> <p>In the last semester of Masters the main objective of the exposure of students' dissertation/Industrial training/ Internship is to elevate their understanding into the practical and experimental aspects of some targeted areas of Environmental Science. This course will develop their analytical ability and it will provide them an apt exposure to work in any research group and will motivate them to execute research in the area of their interest in Environmental Science.</p> <p>Course Outcome:</p> <p>CO-1. Students will be able to plan and strategize a scientific problem, and implement it within a reasonable time frame.</p> <p>CO-2. It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project.</p> <p>CO-3. In addition, students will be able to know environmental data analysis and their interpretation that will be very helpful for government for policy making and ecological balancing.</p> <p>CO-4. Also, students will be able to become as expert in field of GIS and Remote sensing, Environmental Impact Assessment or any other field of environment as per his dissertation work.</p> <p>CO-5. Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.</p> <p>For project work and dissertation, the area of the work would be to be decided by the advisor/mentor.</p> <p>On completion of the project work, students have to submit the work in the form of a dissertation followed by oral presentation in the presence of faculty members.</p>

APPENDIX-II

Guidelines for preparing Research Project/Dissertation is available at link:

http://14.139.237.190/upload_pdf/01_02_2023_Guidelines_for_Project_Lit_Survey_Dissertation.pdf