Department of Environmental Science
Integral University

Effective from Session:							
Course Code	ES 412	**Title of the Course**	Principles of Ecology and Biodiversity	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	I	**3**	**0**	**1**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Upon finishing the course students will be able to come up with a conceptual and fundamental understanding of the environment and its functional unit. understand the concepts and principles of Ecology The student will understand the structural and functional aspects of biodiversity and the need for its conservation. The course is designed to get the students familiarized with modern tools and techniques and their appropriate use to conduct research. Recognize and justify the importance of ecological interactions in shaping the structure of ecological communities To gain an understanding of status of the planet's biological diversity, basic concepts and scientific principles of conservation and global patterns in biodiversity, current efforts to conserve biodiversity on global, national and local scale, practical issues with local conservation.						

Course Outcomes	
CO1	Understanding the basics of Ecology and biodiversity to students coming from different backgrounds.
CO2	Helps in knowing ecological concepts in population dynamics and apprehending the knowledge of species and community ecology
CO3	Analyze various threats to our biodiversity and ecosystems and able to suggest measures for conservation Strategies.
CO4	Trained effectively and scientifically to convey the message of sustainable use of resources and conservation of biodiversity to the public and the young generation
CO5	Ensure that students are in touch with the latest developments, especially concerning Government policies, international agreements, and organizations working for environment conservation

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Ecology	Basic concepts and definitions: ecology, autecology; synecology; landscape, habitat and niche, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; major terrestrial biomes. Ecological amplitude; Liebig's Law of Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; types of niches: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation	7	CO1
2	Planet Diversity and Genesis	Diversity of life; origin of life on earth and Speciation; Human Ecology and Human Settlements, Evolution of early life and changes in earth's atmosphere. Mendelian genetics – and Darwin Wallace's theory of inheritance. Five kingdoms overview; Monera, Protists, Fungi, plant and animal kingdoms.	7	CO1&2
2	Population Ecology	Concept of population; characteristics of population: density, natality, mortality, life tables, survivorship curves, age structure; population growth form: exponential, logistic; r- and k selection; dispersion, distribution, fluctuation, interaction, and regulation. Concept of metapopulation;	5	CO2
3	Community Ecology	Concept of major and minor community; approach of community study: zonal and gradient. Species diversity, discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; ecological succession: primary and secondary successions, models and types of successions, the concept of climax, examples of succession, Models of succession: competitive and stress-tolerance strategies.	6	CO3
4	Ecosystem Ecology	Ecosystem- Definition, Types of ecosystems: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem. function; ecosystem metabolism; ecosystem connections; ecological efficiencies; ecological pyramids. Biogeochemical cycles. Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; and impacts of invasion on ecosystems and communities.	8	CO4
5	Concept of Biodiversity	Introduction, Concept, Definition, types, source, need, and Scope of Biodiversity Science, Threats to biodiversity, major causes. IUCN threat categories, Red data book. Endangered and threatened animals and plants of India. Mega diversity zones and Hotspots, concepts, distribution and importance. Strategies for biodiversity conservation, principles of biodiversity conservation, In-situ conservation and Ex-situ Conservation. Theory of reserve design.	5	CO5
6	Ecosystem Restoration and Management Practices	Global biodiversity and its importance, Different approaches of biodiversity conservation and management, registering biodiversity. Valuing biodiversity resources and their contribution to agriculture, community health, and the environment. Causes of biodiversity loss. Techniques of species reintroduction and restoration of the degraded habitat. Biodiversity policy and legislation. Wildlife conservation and management: Status of biodiversity conservation in India	7	CO4
7	Conservation Practices in India and the World	- Organizations involved in resource conservation IUCN, WWF, UNEP, UNESCO, Biodiversity International, IPGRI, FAO, BSI, ZSI.. General account on activities of DBT, BSI, NBPGR, ZSI, FSI, NBFGR and NBAGR NFPTCR, Sacred groves, and Biodiversity register.	6	CO4&5
8	Practical on ecology	• To determine the minimum size of the quadrat by the species-area-curve method. • To determine the minimum number of quadrats to be laid down in the field under study. • To study the community by quadrat method by determining the frequency, density, and abundance of different species present in the community. • To study the vegetation by line transects method, determining the frequency of individual species. • Digestion, enumeration of Diatom taxa and calculation of Index values. • To study the vegetation of the given area by a physiognomic method Biological Spectrum Method. • To compare the biomass and net primary production of ungrazed and grazed grassland. • To record the abiotic components i.e. pHs, turbidity, DO, temperature, salt and conductivity of water in a pond ecosystem. • To study the ecological adaptations of a hydrophyte and a xerophyte.	20	CO1,2,3, 4&5

Reference Books:

E.P.Odum (1996) Fundamentals of Ecology, Nataraj Publisher. Dehra Dun.

K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC,Boston

M.C.Dash (1994) Fundamentals of Ecology, Tata McGraw Hill. New Delhi.

M.C.Mollesh Jr. (1999) Ecology-Concepts and Application, McGraw Hill, New Delhi.

E.J. Kormondi (1999) Concept of Ecology, Prentice Hall of India, New Delhi

Chapman, J.L. and Reiss M.J. (2005) Ecology Principles And Applications, Cambridge University Press, London.

E.P.Odum and G.W.Barrett (2005) Fundamentals of Ecology, Thomson Asia Pvt. Ltd., Singapore.

e-Learning Source:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1	1		1					1	2	1	2				
CO2	3	2	1	1							1	2	1	1				
CO3	3	2	2	2	2	2					2	2	1	1	1			
CO4	3	3	2	2	2	3			1		3	2		2	2			
CO5	3	2	3	3	2			1	1	1	3	3	2	1	2			

1-Correlation Low Correlation; 2- Moderate Correlation; 3- Substantial

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	**ES 413**	**Title of the Course**	**Fundamentals of Natural resources**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	Natural Resource	**Co-requisite**					
Course Objectives	To know the concept of natural resources, and their management, to understand the management strategies of forest, land , energy, water, coastal and marine resources.						

Course Outcomes	
CO1	To know the concept of natural resources and their types., conservation and preservation.
CO2	The understand the management of forest and land resources.
CO3	To understand the methods for management of energy and water resources.
CO4	To gain knowledge of management of costal and marine resources and wetland conservation
CO5	To know the approaches of resources management.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Concept of natural resources	Concept of resource, classification of natural resources. Factors influencing resource availability distribution and uses. Conservation and preservation	8	CO1
2	Forest Resources and its management	Forest vegetation, status and distribution, major forest types and their characteristics. Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people, forest management. Developing and developed world strategies for forestry.	8	CO2
3	Land resources	Land as a resource, recent changes in land use pattern, land use planning. Landscape impact analysis, wetland ecology & management.	6	CO2
4	Management of Energy Resources	Growing energy needs, renewable and non-renewable energy sources, solar photovoltaic and solar thermal, wind energy, tidal energy, ocean energy (OTEC), geothermal energy; biomass gasification; energy recovery from wastes; bio-fuel; nuclear energy and management of nuclear wastes; energy conservation and energy management; national energy policy.	8	CO3
5	Water resources and its management	World water balance, conservation of freshwater resources; integrated water resource management; rainwater harvesting; watershed management; environmental issues of lakes, dams and reservoirs; river linking and its impacts	8	CO3
6	Management of Coastal and Marine Resources	Coastal resources; mangrove and salt marsh ecosystems; Integrated coastal zone management (ICZM); Threats to marine ecosystem; marine resource management.	8	CO4
7	Wetland conservation	Wetlands- definition, functions, ecology and biodiversity; wetland loss and degradation; Ramsar sites; strategies for wetland conservation and management; wetland mapping	6	CO4
8	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 – Poverty in developing countries, causes and link with resources scarcity and poverty.	8	CO5

Reference Books:

1. Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303
2. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876
3. Agarwal, K.C., 2001. Environmental Biology, Nidhi Publication Ltd. Bikaner
4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publishing House

e-Learning Source:

https://youtu.be/aT8BBG7ncxI?si=4tVVYoETKYyUZMNc
https://www.youtube.com/live/z3bvX7y5JjY?si=EJBirhX_mSJEAxSu

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	2	1	1	2	3	2	-	-	-	-	1	1	3	1	3	-
CO2	2	1	2	1	1	2	3	2	-	-	-	-	1	2	3	1	3	-
CO3	2	1	2	1	1	2	3	2	-	-	-	-	1	3	3	1	3	-
CO4	2	1	2	1	1	2	3	2	-	-	-	-	1	2	3	1	3	-
CO5	2	1	2	1	1	2	3	2	-	-	-	-	1	2	3	1	3	-

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2024-2025							
Course Code	**ES 414**	**Title of the Course**	**Environmental Statistics and Computer Applications**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	I	**2**	**1**	**-**	**3**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course contains descriptive statistics as well as hypothesis evaluation in environmental science. The students learn about the principle of statistics, including sampling methods, sources of error, and various statistical tests for different types of data that can be applied for further research in environmental studies. An effort has been made through this course to provide some useful tools "to get to the grips" of environmental problems and to encourage the students to develop the necessary craft and art.						

Course Outcomes

CO1	Learn the basic concepts of Environmental statistics.
CO2	Introduced to various common tools that are used for data classification and analysis.
CO3	Understand the importance of hypothesis testing and also learn prediction models.
CO4	.To gain knowledge of mathematical model.
CO 5	Computer applications of statistics in Environmental Science will be introduced through various examples

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Design of sample survey**	Concepts of population and sample, need for sampling, census and sample surveys, designing of a questionnaire, sampling and non-sampling errors, sample size determination, estimation of mean and total in each case and their variances. Stratified sampling, allocation problems in stratified sampling, estimation of mean or total in each case and their variances. Systematic sampling: Linear and circular systematic sampling.	8	CO1
2	**Data analysis**	Population, Sample, variable, parameters, primary and secondary data, screening and representation of data, frequency distribution, histogram, frequency polygon, ogive curves. Mean, median, mode, quintiles, percentiles Measures of dispersions: range, quintile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness, kurtosis Bivariate data: Scatter diagram, correlation coefficient, properties (without proof) interpretation of correlation coefficient, linear regression, Fitting of lines of regression, coefficient, Coefficient of determination, partial and multiple correlation coefficients	12	CO1
3	**Probability and distributions**	Probability: Sample space, events, Definition of probability (mathematical and frequency approach) independent events, addition and multiplication laws, conditional probability examples Probability distributions: Random lea viable p.m.f. Expectation and variance, Bernoulli, Binomial, Poisson, uniform, Normal distributions, mean and variance of these distributions (without proof) use of these distributions to describe biological medals.	12	CO2
4	**Testing of hypothesis**	a) Simple random and stratified random sampling, sampling distribution, standard deviations of a sample statistic, hypothesis critical region, errors, large sample test for mean, proportion, equality of means (when variance is known and when it is unknown) b) Chi-square test for variance, t-test for population mean and equality of population means, chi-square test for goodness of fit and independence of attributes, p-value of a statistic	8	CO3
5	**Mathematical models**	Mathematical models: Exponential, logistic models for population growth, Lotka Voltera Prey and predator model, box model, Gaussian plume, point source stream model Leslie's matrix model.	8	CO4
6	**Computer applications**	Computer applications: Introduction to computer: Input and output devices, computer software, types of software's, hardware storage devices, Operating systems, programming languages. Introduction to MS EXCEL, use of the worksheet to enter data edit data, copy data, move data, use of inbuilt functions for computations of various statistical constraints, use of charts, Introduction to MS-Word, word processor, editing, coping, moving, formatting, table, insertion, etc.	12	CO5

Reference Books:

Bio-statistic: A Foundation for analysis in the health sciences: Wayne W – Daniel John Wiley and sons Inc

Survival models and data analysis: Elandt – Johnson and Johnson, John Wiley and sons Inc.

Statistical Methods for Environmental and Agricultural Sciences A – Reza Horseman CRC Press Boca Raton Network

Computer Fundamental: P. K. Sinha BPB Publications New Delhi

Digital Computer fundamentals: Thomas C. Bastee, Mc Graw Hall international book Company Tollyo

Mathematical models in Biology and Medicine: J. N. Kapur Affiliated East-west Press Pvt. Ltd., Bangalore.

e-Learning Source:

MOOC, NPTEL ,Pathsala

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	3	2	3	3	1	2	2					3	1	2	1	1	
CO2	1	3	2	3	3	1	2	2					3	1	2	1	1	
CO3	1	3	2	3	3	1	2	2					3	1	2	1	1	
CO4	1	3	2	3	3	1	2	2					3	1	2	1	1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	**ES 415**	**Title of the Course**	**Forest, Wildlife and Ecotourism**	**L**	**T**	**P**	**C**
Year	M.Sc. I[st] Year	**Semester**	I	**2**	**1**	**0**	**3**
Pre-Requisite	Natural Resource	**Co-requisite**					
Course Objectives	The course is designed to provide basic knowledge of forest ecology, wildlife and Eco-Tourism. The course is aimed to teach the methods and data used for Interesting Eco-tourism. To provide knowledge of the Impact of Eco-tourism. To develop knowledge of Wildlife Management.						

Course Outcomes

CO1	Have an enhanced knowledge of forest Ecology
CO2	Be able to explain Wildlife Conservation and related problems and wildlife Management
CO3	Be able to Be able to explain Concept scope of Ecotourism
CO4	To gain knowledge of types of ecotourism
CO5	. Be able to explain the impact of ecotourism

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Forest Ecology	Forest ecology, forest community dynamics, forest community structure and function, phytogeography and zoo-geographic regions of India, Basic concept of biodiversity, history of biodiversity conservation, Conservation of natural resources (Hotspot areas, Wildlife Sanctuaries, National parks, Biosphere reserve-terrestrial and aquatic, Botanical Gardens, Zoological Parks), Important Plant and wildlife ecological indicator species, endangered species, Coral reefs, Mangrove forest	12	CO 1
2	Wildlife Ecology and Conservation	Wildlife Ecology, Basic concepts, Wildlife habits and habitat. Wildlife habitat and its component Wildlife conservation: Definition, Concept, significance. Wildlife conservation in India, In-situ and Ex-situ wildlife conservation, Role of protected areas in wildlife conservation, some rare and threatened wildlife species of the world particularly India, special project for endangered species, Project tiger, Gir Lion Project, Crocodile Breeding Project.	12	CO2
3	Wildlife Management	Wildlife Management process, elements of wildlife management in India. Role of local communities in wildlife management – Man-wildlife conflicts - Poaching of wildlife - Wild life conservation laws - The Wildlife (Protection) Act, 1972 (2002 amendment).	08	CO2
4	Introduction to Eco-Tourism	History and scope of ecotourism; Components of ecotourism; Principles and characteristics of ecotourism; Ecotourism planning: Site diagnostics, Target groups; Ecotourism industry and its stake holders; Resources and products of ecotourism; Commercialization of ecotourism	08	CO3
5	Types of Ecotourism	Tourism vs. Ecotourism; Types: Agro-ecotourism, Geo- ecotourism, Cultural ecotourism – tangible and intangible heritages and tourism, Sensitive areas of ecotourism; Ecotourism management plans	08	CO4
6	Impact and sustainability of Eco-tourism	Impact of Ecotourism, Types and Degree of Impacts from Ecotourism activities– Ecotourism related Organization. Positive and negative impact of Ecotourism, Responsible ecotourism, Impact of eco-tourism on Economy. Sustainability of ecotourism; Ecotourism in developed countries; Community-based ecotourism: case studies; Joint forest management, Role of NGOs; Ethical and legal aspects; Ecotravel and environmental awareness; Impacts of ecotourism, Green report card, Eco-labelling; Environmental sustainability practices.	12	CO5

Reference Books:

1-Dasman RF (1968) Environmental Conservation: John Wiley and Sons, New York.

2-Mukherjee N (2008) Ecotourism and sustainable Development. Cybetech Publications, New Delhi.

3-Prabhas Chandra (2003) Global Ecotourism, Kaniskha Publishers, New Delhi.

4-Sinha, P.C (2003) Encyclopedia of Ecotourism, Volume I, II and III, Anmol Publications Pvt. Ltd., New Delhi.

5-Weaver DB (2001) The Encyclopedia of Ecotourism, CABI Publishing, UK.

6- Kumar Arvind. 2005. Biodiversity and Conservation, Today & Tomorrow's Printers and Publishers New Delhi.

e-Learning Source:

https://www.slideshare.net/chandikeehelamalpe/ecotourism-64745161

https://www.slideshare.net/ravindraprasad5/eco-tourism-42047943

https://www.slideshare.net/AndrewMyrthong/ecotourism-57238509

https://slideplayer.com/slide/6063870/

https://www.slideshare.net/apoorvkumar9277/wildlife-conservation-37245301

https://www.google.com/search?client=firefox-b-d&q=Wildlife+Management+ppt

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	2	2	2	1	-	-	-	-	-	2	2	2	2	2	-
CO2	3	2	2	2	2	2	1	-	-	-	-	-	2	1	1	2	2	-
CO3	3	3	2	2	2	2	2	-	-	-	-	-	2	2	1	2	1	-
CO4	3	3	3	2	3	2	2	-	-	-	-	-	3	3	2	3	1	-
CO5	2	2	2	2	2	3	1	-	-	-	-	-	2	3	3	2	3	-

7- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University
(Programme: M. Sc)

Effective from Session:							
Course Code	**ES416**	**Title of the Course**	**Field Project**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	II	**2**	**0**	**0**	**2**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Upon finishing the course students will be able to come up with a gain of professional work in field project experience.						

Course Outcomes	
CO1	To apply theoretical concepts learned in degree course work to a practical situation
CO2	To obtain experience with relevant materials and methodologies.
CO3	Achieve/complete assigned target(s)/ task(s) given by the person to whom the intern or apprentice is reporting (Supervisor)

Unit No.	**Title of the Unit**	**Content of unit**	**Mapped CO**
1	Field Project	Students are encouraged to undergo research projects in a suitable industry, consultancy, research laboratory, institute, Protected Areas etc. to get experience of environmental management and of natural habitats. Field project work will be initiated at the start of the Semester. Each student will work independently on the topic. A supervisor will be assigned to each student. The students will undertake fieldwork in terms of the collection of data, field surveys, data analysis and report/thesis writing. The student will submit a final project report and thesis to the funding agencies, collaborators, and to the Department. The field project report consists of exclusive findings and has an Introduction, Study Area, Methodology, Results, Discussion, and References. The thesis must consist of a review of the literature produce a deep insight of the subject based on personal research and must have inclusive findings. The thesis will have to be submitted for appraisal and acceptance by the University. The students should submit their thesis in the following format: Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study. Chapter II: Methodology with Material and Methods: Description of the issue, methodology adopted for the study. Chapter III: Experimental: Presentation of data collected and detailed analysis of results. Chapter IV: Result and Discussion: Discussion on the data and results obtained and Presentation of the method suggested to solve the problem. Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation. Bibliography or References: A list of references cited in the text. The Field Project Report/thesis should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. Students will have to submit their field project report/thesis one month Before the practical examination at the end of Semester. The field work report/thesis will carry 100 marks (Internal marks 25 and External marks 75). Students have to present a Power Point Presentation to defend their thesis. Assessment of the fieldwork shall be done by the external examiner appointed by HOD, Integral University.	CO1,2,3

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2		1			1			2	1		1	2				
CO2	3	2	1	1					1		1			1				
CO3	3		2	2	2	2					2		1	1	1			

1-Correlation Low Correlation; 2- Moderate Correlation; 3- Substantial

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Department of Environmental Sciences
Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	ES417	**Title of the Course**	**Synergies in Microbial Ecology and Biotechnology**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	II	**3**	**0**	**1**	**4**
Pre-Requisite	B.Sc	**Co-requisite**					
Course Objectives	The course aims to provide students with a comprehensive understanding of environmental microbiology and biotechnology, emphasizing the diversity and ecological roles of microorganisms. Through a combination of theoretical knowledge and practical applications, students will develop proficiency in advanced laboratory and molecular techniques for environmental analysis. The course seeks to equip students with the skills to design and implement bioremediation strategies for diverse environmental settings, fostering a deep appreciation for ecological principles and sustainability. Additionally, the program aims to integrate microbial processes into the fields of agriculture and aquaculture, promoting sustainable solutions for plant growth, biocontrol, and waste management. Ultimately, the course aspires to cultivate a practical and problem-solving mindset, enabling students to apply their knowledge effectively in addressing contemporary challenges in environmental microbiology and biotechnology.						

Course Outcomes	
CO1	Develop a comprehensive understanding of microbial diversity and taxonomy, and appreciate the ecological roles played by microorganisms in various natural environments.
CO2	Acquire proficiency in a range of laboratory and molecular techniques, including DNA sequencing, PCR, and metagenomics, enabling the application of cutting-edge methods in environmental microbiology research.
CO3	Gain the skills to design and implement effective bioremediation strategies for the cleanup of pollutants in soil, water, and industrial settings, considering ecological principles and sustainability.
CO4	Apply microbial principles to enhance agricultural practices, aquaculture, and environmental health, with a focus on sustainable solutions for plant growth promotion, biocontrol, and waste management.
CO5	Develop hands-on expertise through practical applications, including laboratory experiments, field trips, and case studies, allowing students to integrate theoretical knowledge into real-world scenarios and problem-solving in environmental microbiology and biotechnology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Foundations of Environmental Microbiology and Biotechnology	Introduction to Microbial Diversity and Taxonomy, Principles of Microbial Ecology and Environmental Interactions, Historical Development and Milestones in Environmental Biotechnology, Current Trends and Innovations in the Field	6	CO1
2	Microbial Physiology and Metabolism in Environmental Systems	Cellular Structure and Function of Microorganisms, Metabolic Pathways and Energy Flow in Microbial Communities, Adaptations of Microbes to Environmental Stresses, Microbial Interactions: Competition, Mutualism, and Synergies	6	CO1 & CO2
3	Microbes and environment	Microbes present in water, soil, and air. Basic principles of microbial transformation of organic matter, biodegradation, acclimatization of wastes, and microbial inhibition mechanisms. Pure and mixed cultures, Aerobic and anaerobic metabolism, microbial growth and dynamics.	6	CO2
4	Techniques in Environmental Microbiology and Biotechnology	Tools and techniques in environmental biotechnology, Plant cell and tissue culture technology, Plasticity, and Totipotency, The culture requirements, Plant cell culture media, Culture types, In vitro regeneration pathways: organogenesis and somatic embryogenesis, Acclimatization, and hardening, cell suspension culture. Micropropagation and clonal propagation, Plant cell and tissue culture in forestry, In vitro conservation of germplasm, gene bank, basic concepts and techniques for plant transformation, clean gene technology. . Microbial Cultivation and Isolation Techniques, Molecular Techniques: DNA Sequencing, PCR, and Metagenomics, Omics Approaches: Genomics, Proteomics, and Metabolomics, Analytical Techniques for Monitoring Microbial Processes	8	CO2
5	Environmental Bioremediation and Waste Management	Concept of Bioremediation. Biodegradation of Pollutants by Microorganisms, Bioremediation Strategies for Soil and Water Cleanup, Microbial Contributions to Solid Waste Management, Innovative Approaches to Sustainable Waste Treatment	6	CO3
6	Applications in Agriculture, Aquaculture, and Environmental Health	Microbial Plant Growth Promotion and Soil Health, Biotechnological Applications in Aquaculture Microbial Biocontrol in Agriculture, Microbial Indicators for Environmental Health Assessment	5	CO4

7	Practical Applications in Environmental Microbiology and Biotechnology	1. Laboratory Techniques in Microbial Isolation and Identification 2. The Components Use and Care of the Compound Microscope 3. Gram staining technique. 4. Bacterial examination of water. 5. Environmental biotechnological tools used. 6. Bioinformatics tools used\ 7. GMO impact assessment 8. Phytoremediation assessment 9. Water and soil analysis upon bioremediation 10. Determination of LD 50 / LC 50 11. Biochemical analysis of seeds under toxic conditions. 12. Application of Molecular Techniques in Environmental Analysis 13. Bioremediation Experiments: Design and Implementation 14. Microbial Processes in Industrial Settings: Scale-up and Optimization	15	CO5
8	Case studies	Field Trips and Case Studies: Real-world Applications of Environmental Microbiology and Biotechnology	08	CO5

Reference Books:

1-Subba Rao NS (2004) Soil Microbiology. 4th Edition, Oxford & IBH Pubilshing Co. Pvt. Ltd., New Delhi.

2-Subba Rao NS (1995) Biofertilizers in Agriculture and Forestry. 3rd Edition, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

3-Robert LTate (1995) Soil Microbiology. 1st Edition, John Wiley & Sons, Inc. New York.

4-Atlas RN & Bartha R (1998) Microbial Ecology, 4th Edition, Benjamin Cummings.

5-Jogdand SN (2004) Environmental Biotechnology. Reprinted & published by Himalaya Publishing House, Mumbai.

6-Singh DP & SK Dwivedi (2005). Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi. • Evans, G.M. and Furlong J.C. 2003. Environmental Biotechnology: Theory and Application. John Wiley and Sons.

- Glick, B.R. and Pasternak J.J. 2007. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C. ASN Press.
- Horton, H.R., Moran L.A., Perry M.D. and Rawn J.D. 2006. Principles of Biochemistry, Pearson Education International.
- Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York.
- Metcalf and Eddy (Eds).2003. Wastewater Engineering: Treatment and Reuse.

e-Learning Source:

SWAYAM

MOOC

e-Skill India

Coursera

Udemy

National Digital Library of India

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	2	1	1	1	2		-	-	-	-	2	1	1	1	3	-
CO2		1	1	2		2	3		-	-	-	-	2	1	2	1	2	-
CO3		2		1	1	2	2		-	-	-	-		1	1			-
CO4	2	1	1	1	2	3			-	-	-	-	2	3		1	2	-
CO5	2			2	1	3	2		-	-	-	-		3	1	1	2	-

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	**ES 418**	**Title of the Course**	**Environmental Instrumentation Techniques**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	II	**2**	**1**	**1**	**4**
Pre-Requisite	B.Sc./B.Sc.(H)	**Co-requisite**	Basic knowledge of chemistry, physics				
Course Objectives	The aim of this course unit is to introduce the student to a wide variety of modern analytical techniques used in environmental science research. It is designed to couple the theory of equipment operation with a basic understanding of the chemical principles involved.						

Course Outcomes

CO1	Review the basics of the major analytical techniques and how the techniques can be applied in environmental sciences.
CO2	Able to understand the physic-chemical parameters and their analysis methods.
CO3	Learn different type of microscopy.
CO4	Aware students about photometry.
CO5	Students will learn about compound separation and chromatography.
CO 6	Gain knowledge about environmental microbiological tools & techniques.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Sampling of Air, Water and Soil	Sample Preparation: Interferences and Detection Limits, Quality Control in the Laboratory: Equipment Calibration and maintenance, Matrix spike and Blank samples; Sampling equipment; Data treatment such as Accuracy, Precision, Standard deviation, Types of errors, Minimization of errors, Significant figures, Criteria for rejection of data.	6	CO1
2	Physicochemical parameters	Definition and determination of Conductivity, pH, DO, BOD, COD, and Measuring instruments. Principles and application of Gravimetric, Titrimetry.	6	CO2
3	Microscopy	Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, atomic force microscopy, confocal microscopy, fixation and staining	6	CO3
4	Photometry	Principles and application of Colorimeter, UV-visible spectrophotometer, Flame Photometer, Atomic Absorption Spectrometer,	6	CO4
5	Separation Techniques	Principle and process of solvent extraction, Extraction reagents and Practical applications; Chromatography – principle and application of Thin layer and Ion exchange chromatography, Column chromatography), Gas chromatography, Gas-liquid chromatography, GC-MS, High-pressure liquid chromatography. Liquid Columen Chromatography and mass spectrophotometry (LC-MS).	8	CO5
6	Microbiological Tools & Techniques	Concept of Total microbial count, Total coloform, Pathogen detection, Biochemical test. Principle & Application of Laminar Air Flow Chamber, Biological Oxygen Demand Incubator,Colony counter.	6	CO 6
7	Practical	Practical for Physicochemical parameters, Microscopy and Photometry	11	CO1,2, 3,4,5,6
8	Practicals	Separation Techniques and Microbiological Tools & Techniques	11	

Reference Books:

1) Methods in Environmental Analysis: Water, Soil and Air. PK Gupta

2) Hand Book of Analytical Instruments2006 McGraw-Hill Education Private Limited

3) Physicochemical Parameters of Water and Method of Their Analysis

4)Handbook of Process Chromatography: A Guide to Optimization, Scale Up, and Validation Gail K. Sofer.

e-Learning Source:

https://www.standardsmedia.com/Instrumentation-1109-mc.html.

https://www.nepjol.info/index.php/SW/article/viewFile/2667/2361

https://byjus.com/chemistry/methods-of-separation/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	-	3	3	2	-	-	-	-	-	3	2	3	1	3
CO2	3		2	1	3	-	3	-	-	-	-	-	-	2	3	-	3
CO3	3			1	3	2	2	-	-	-	-	-	3	2	3	1	3
CO4	3	2	1	1	-	2	-	-	-	-	-	-	3	2	-	1	3
CO5	3	1	1	1	3	2	2	-	-	-	-	-	3	2	3	1	3
CO 6	3	1	1	1	3	2	2	-	-	-	-	-	3	-	3	1	3

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-2025

Course Code	**ES419**	**Title of the Course**	**Disaster Management and Preparedness**	**L**	**T**	**P**	**C**
Year	I	Semester	II	2	1	0	**3**
Pre-Requisite	Environmental Studies	**Co-requisite**					
Course Objectives	The course is intended to provide a general insight into the dimensions of environmental hazards caused by nature as well as induced by human developmental activities and gives an understanding of disaster preparedness, mitigation and management. To provide basic concepts about types of Natural and Man-made Disaster. The course aims to discuss Disaster Risk Reduction and create awareness among the students about disaster mitigation strategies. The course is designed to provide knowledge about the role of disaster medicine and disaster medical management and to provide knowledge about Disaster Epidemiology and Environmental health hygiene during the Disaster. To develop knowledge about the Role of various organizations for disaster management.					

Course Outcomes

COl	Students will be able to learn general concepts of Disasters and their relationship with development.
CO2	Students will be able to learn about Approaches to Disaster Risk Reduction
CO3	Students will be able to learn about the Principles of Disaster Medical Management Public Health Response and International Cooperation
C04	Explain how hazards can be mitigated, through prediction, prevention, and preparation; but also the problems involved in these approaches
CO5	Students will be able to learn about Disaster risk management in India through the different case studies

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to Disaster	Concepts of Hazard, Vulnerability, Risks, Natural Disasters, and Man-Made Disasters, Technological disasters, Risks, Political, Social, and Economic impacts of Disasters, Equity issues in disasters, Relationship between Disasters and Development and vulnerabilities, Human Resettlement and Rehabilitation issues during and after disasters, Inter-sectoral coordination during disasters.	5	CO1
2	Approaches to Disaster Risk Reduction and Preparedness	Concept of Disaster Risk Reduction, Disaster preparedness and mitigation, forecasting and warning systems, contingency planning, terrorism preparedness, community emergency response team, training, India Disaster Resource Network; Case studies Disaster management: Pre-disaster phase - vulnerability analysis, hazards monitoring, tracking and modeling, disaster planning; Disaster phase - disaster responses operation-planning and practice, emergency management, emergency service systems, rescue operation; Post-disaster phase - Relief and recovery, disaster education, alternatives, and new directions: conceptualizing crisis management; Rehabilitation and resettlement.	8	CO2
3	Principles of Disaster Medical Management	Introduction to disaster medicine, Various definitions in disaster medicine, Disaster recovery about disaster medical management, National Assessing the nature of hazardous material - Types of injuries caused, Self-protection contaminated area and decontaminated area — Pre-hospital medical management of victims — Triaging medical & psychosocial identification of hospitals and other medical facilities to offer efficient disastrous medical service — Safe patient transportation —Identification of valuable groups.	8	C03
4	Public Health Response and International Cooperation	Principles of Disaster Epidemiology, Rapid Health Assessment, Outbreak Investigation Environment health hygiene and sanitation issues during disasters, Preventive and prophylactic measures, international cooperation in funding on public health during a disaster, International Health Regulation, United Nations International Strategy for Disaster Risk Reduction, United Nation Disaster Management Team, International Search and Rescue Advisory Group.	8	CO4
5	Disaster Risk Management in India	Introduction to risk evaluation; Definition of risk and fundamentals of risk analysis, Basic methodology in risk assessment: hazard identification, dose-response assessment, exposure assessment, and risk characterization. Design of risk management program; risk estimation, risk evaluation, risk management and risk communication Hazard and Vulnerability Profile of India, Disaster Management Indian scenario, Disaster Management Act 2005 and Policy guidelines, Government agencies and other social organizations relevant to natural calamities; their aims and functions, available assistance and guidance; National Disaster Management Policies Mitigation Strategy, Disaster planning, and Safety regulation; Best Practices in disaster management, Appropriate Technology and local Responses, Indigenous Knowledge, Development projects in India and their impacts, and Logistics management in specific emergencies.	8	CO5
6	Case studies	Case Studies of Natural disasters; nature, causes, and effects; cyclones, tornadoes, floods, drought, earthquakes, avalanches, landslides, forest fire, volcanism, epidemics, and other relevant case studies Man-made and man-induced disasters: industrial accidents, oil spills, chemical and nuclear hazards, biohazards; Terrorism	8	CO1,2,3,4, &5

Reference Books:

1.Natural Disasters — A Guide for Relief Workers— JAC Adhyatme Sadhma Kendra, Mehrauli, N. Delhi.

2.Parasuraman S and Unnikrislman PV (2000) Indian Disasters — Report towards a policy initiative, Oxford University Press,UK.

3.Petalc WJ and Allissoon AA (1982) Natural Hazards Risk Assessment and Public Policy Anticipating Unexpected, Springer-Verlag, New York.

3.Shailendra K. Singh, Subash C, Kundu and Shobu Singh (1998) Disaster Management, Mittal Publications, New Delhi.

4. Cutter, L.1999. Environment risks and hazards. Prentice Hall of India Private Limited, New Delhi

5. Disaster Management in India – A Status Report. National Disaster Management Division, Ministry of Home Affairs, Govt. of India

e-Learning Source:

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

2.1Ais //www.youtube.com/watch?v=uA OLKfQpYA

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	P01	P02	P03	PO4	P05	P06	P07	P08	P09	P010	P011	P012	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
COl	3	2	3	2	1	3	2	1	-	-	-	-	-	1	1	1	1	**-**
0O2	**1**	1	1	1	1	1	3	1	-	-	-	-	1	1	1	1	1	**-**
0O3	**1**	1	1	1	1	-	2	-	-	-	-	-	1	1	1	-	1	**-**
004	2	1	2	1	-	3	2	1	-	-	-	-	-	1	1	1	1	**-**
CO5	**1**	1	1	1	-	1	3	1	-	-	-	-	1	1	1	1	1	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	**ES420**	**Title of the Course**	**Environmental Pollution and Mitigation Strategies**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	B.Sc./B.Sc. (Hons.) with Biological Science/Life Sciences/ Biotechnology/ Microbiology /Agriculture/ Anthropology	**Co-requisite**					
Course Objectives	To provide an insight into the latest concepts of environmental pollution through the understanding of definition, causes, effects, and control of air, water, soil, noise thermal, and nuclear pollution; thereby preparing students to align their carrier goals with the various environmental pollution issues of regional, national and global importance. This will give each student a sense of analyses that can be done, as well as practical experience with them, before designing and carrying out an independent project. Providing the evidence base to support decision and policy making, students should be able to understand pollution problems, consider ways to respond to them, and propose appropriate solutions/actions to reduce (protect, mitigate or prevent) pollution risks when necessary..						

Course Outcomes	
CO1	Have gained awareness of current forms of environmental pollution and an overview of both their causes and consequences to natural, economic, and social systems.
CO2	Students understand the fundamental principles governing the interactions between those systems (i.e. transport of pollutants in the environment)
CO3	Have been exposed to learning examples of good practices of technologies and options used to remediate reduce/eliminate pollution of the environment
CO4	Be able to analyze, synthesize, and evaluate evidence to understand problems and accordingly select control measures and techniques concerning atmospheric, water or terrestrial challenges.
CO5	Students will be able to identify mitigation measures, air treatment techniques, wastewater treatment, wastes treatment, soil remediation

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Air Pollution and its Mitigation	Definition of pollution and its types. Air Pollution- Natural and Anthropogenic Sources- Major Air Pollutants - Types and effects of Air Pollutants-Acid Rain, Greenhouse effect and global Warming-Meteorology and Plume dispersion-Sampling of Air Pollutants- Sox, Nox, Ozone, methane, Hydrocarbons and Particulate Matter. Particulate Matter Control Equipments: Settling chamber, Cyclone, Fabric filter, electrostatic Precipitator, and Wet Scrubbers- Air quality and emission standards.	**12**	**CO1**
2	Water & Marine Pollution and its Mitigation	Water Pollution-sources of water pollution-organic, inorganic and heavy metals- Phenomena of Eutrophication-Transport of Pollutants in the aquatic Ecosystem-Water quality Parameters- Water quality standards- sources, effects, and control measures ocean, oil, and groundwater pollution-Water Sampling techniques- Water remediation techniques: Rhizofiltration, wetlands, lagoons, oxidation pond, and oxidation ditch. Marine Pollution (Sources, regulation and control and criteria for disposal in marine system) Water treatment: Drinking water and wastewater treatment technologies. Designs and functioning of ETP; Concept of ETP, Need of ETP ion Industry, Concept of CETP, Major units in ETP and their functions, recycling of wastewater, recycling of industrial effluent after treatment.	**12**	**CO2**
3	Soil Pollution and its Mitigation	Soil pollution: Sources- Industrial, Domestic, Agricultural (Pesticides, heavy metals, industrial effluents, waste disposal) - Effects of soil pollutants on plants, animals, and groundwater - Soil sampling devices, methods, and analysis remediation techniques: Physical, chemical and biological (bioremediation and phytoremediation).	**6**	**CO3**
4	Noise Pollution and its Mitigation	Noise Pollution: Sources, sound pressure levels, decibels, intensity, and duration - Effects of noise pollution on humans and animals - Noise permissible standards - Noise control measures - greenbelt and noise protective instruments	**5**	**CO4**
5	Radioactive and Thermal Pollution and its Mitigation	Radioactive pollution: Sources, radioactive elements, Effects of radiation on surrounding environment - Radioactive waste disposal methods. Thermal pollution and its causes, impact, and mitigation	**5**	**CO4**
6	Hazardous Waste Management	Classification of hazardous wastes, Hazardous waste generation and disposal, Treatment and disposal methods for hazardous waste, and Regulatory frameworks for hazardous waste management.	**5**	**CO5**

Reference Books:

1."Environmental Science: Toward a Sustainable Future" by Richard T. Wright and Dorothy F. Boorse

2. “Introduction to Environmental Engineering and Science" by Gilbert M. Masters and Wendell P. Ela

3. "Air Quality, Fourth Edition" by Thad Godish and Wayne T. Davis

4. De, A.K., Environmental Chemistry. New Age International (P) Ltd. Publishers, NewDelhi. 2000.

5. Fetter, C.W. Contaminant Hydrogeology. 2nd ed., Prentice Hall, India. 1999.

6. Sanai, V.S. Fundamentals of Soil. Kalayani Publishers, New Delhi. 1990.

7.Sharma, B.K. Environmental Chemistry, Goel Publishing House, Meerut. 2000

e-Learning Source:

1-https://www.manchester.ac.uk/study/masters/courses/list/02180/msc-environmental-monitoring-modelling-and-reconstruction/

2-https://courses.hud.ac.uk/full-time/postgraduate/environmental-monitoring-and-modelling-msc

3-https://www.heavy.ai/technical-glossary/environmental-monitoring

4-Various manuals published by MOEF, CPCB, IPCC etc

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																		
PO-PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	1	1	1			2						2	2	2	2			
CO2	2	1	1	1			2						2	2	2	2			
CO3	2	1	1	1			1						2	2	2	2			
CO4	2	1	1	1			2						2	2	2	2			
CO5							2												

3- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session:							
Course Code	**ES 421**	**Title of the Course**	**Climatology and Meteorology**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	B.Sc. in Science	**Co-requisite**	Basic knowledge of the environment				
Course Objectives	This is an introductory course to climatology that will help students comprehend the changing environment. Students will be exposed to the various components of climatology and meteorology including thermodynamics, radiation, synoptic, physical meteorology, mesoscale and large-scale dynamics. This course is a foreword to the basic principles leading to major meteorological processes and climate variations on planet Earth. Emphasis is made of planetary energy budgets, planetary winds, global air circulation patterns, and vertical movements of air, atmospheric lapse rate, and regional climates. Students will understand the role of atmospheric parameters, their global patterns, and their importance in energy exchange, heat transfer, cloud formation, and precipitation.						

Course Outcomes	
CO1	Be able to define the structure and composition of the atmosphere and how it has changed with time;
CO2	Be able to identify the sources causing solar radiant energy variations on Earth and can describe global radiation balance and atmospheric stability;
CO3	Demonstrate knowledge of a wide range of atmospheric phenomena and their roles in affecting weather and climate on local, regional, continental, and global scales including vertical motion of air, clouds, precipitation, winds and storms, fronts, and air masses;
CO4	Be able to describe the general distribution of the world of temperature, precipitation, wind patterns and climates - and the factors and physical mechanisms which cause these distributions.
CO5	Become acquainted with issues related to atmospheric sciences, such as air pollution and climate change, and contribute to solving problems in the atmospheric sciences and related disciplines, through service as educators, researchers, and leaders in academia, government, the private sector, and civil society.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Climatology**	• Introduction: Weather and climate concepts - World climate system - climate of the hemispheres. Introduction of climatology, fundamental principles of climatology, the climate system: controls on climate. Climate classification, earth-sun relation, coastal effect on climate, orographic effect on climate, different climate zones, trends of climate and its variability, and climate modification. • Indian climatology: seasonal pattern of different weather elements, and different climate methods. Regional distribution and seasonal variation of cloud, precipitation and fog, etc.	12	CO1 &2
2	**Meteorology, atmospheric stability and chemistry**	• Meteorological parameters: – Pressure, temperature, wind, humidity, radiation, atmospheric stability adiabatic diagrams, turbulence, and diffusion. Scales of meteorology. Types of Meteorology, Atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model. Chemistry of atmospheric particles and gases; Radiation balance and budget. Cloud classification, cloud condensation nuclei, Ice nuclei	12	CO, 1 & 2
3	**Atmospheric Energy Releases**	• Relative humidity and vapor pressure, Absolute and specific humidity, Air mass, sources and classification of air masses, fronts and frontogenesis, classification of fronts, condensation, and adiabatic processes, clouds, and fog, forms of precipitation, Convective precipitation and thunderstorms, Orographic precipitation, Cyclonic and frontal precipitation, World precipitation regions, Water balance of the atmosphere.	08	CO 3 &5
4	**Global warming and climate change**	• Evolution and development of Earth's atmosphere; atmospheric structure and composition; the significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles, atmospheric windows. Trends of global warming and climate change; drivers of global warming and Global Warming Potential (GWP) & climate change; the impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO2 fertilization and agriculture; impact on economy and spread of human diseases.	12	CO 4 &5
5	**Meteorological Instrumentation**	• Barometer, hygrometer, anemometer, rain gauge, evaporimeter, thermometry, altimeter, upper air measurement, measuring solar and earth radiation, chart recorder, data logger, conventional measurements of pressure, temperature, humidity, wind, precipitation, visibility, clouds, soil temperature and humidity. Ocean temperature, salinity, wave, height, currents, self-recording instruments radiosondes, radiometer sondes, ozonesonde, LIDARS, SODARS, RADAR	08	CO 2,3,4 &5
6	**Forecasting and application**	• Reading a Weather Map, Observation, Analysis and Prediction, Organization of the National Weather Service, and Long-Range Forecasts. • Applied climatology: climate and water resources, climate and biosphere, climate and agriculture, Applications of micrometeorology to vegetated surfaces, urban areas, human beings, and animals.	08	CO5

Reference Books:

Physics of the Atmosphere and Climate, Murry L. Salby, Cambridge University Press, 2012.

Introduction to Environmental Physics: Planet Earth, Life and Climate, Peter Hughes & N.J. Mason, CRC press, 2001.

Environmental Physics, Clare Smith, Psychology Press, 2001

James R. Holton and Gregory J. Hakim, An Introduction to Dynamic Meteorology, Academic Press, 2012.

An introduction to Meteorological instruments and measurement – Thomas D. Defelice

Climatology - Bernhard, Haurwitz and James M. Austin.

Dynamical and physical Meteorology, George J.Haltiner and Frank L. Martin.

e-Learning Source:

SWAYAM, MOOC, e-Skill India, Coursera, Udemy, National Digital Library of India

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1		2			2	1	3			1	3	1	2	
CO2	3		2			1		2	3	2		2		
CO3	2	1		1	2			2		1			2	
CO4			3	1		2		2	1	1	2	3	1	
CO5	3	1			3	2			1		3	1	3	

4- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-25

Course Code	**ES422**	**Title of the Course**	**Environmental Toxicology and Health Risk Assessment**	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**2**	**0**	**1**	**3**
Pre-Requisite	B.Sc	**Co-requisite**					
Course Objectives	This course provides a comprehensive understanding of environmental toxicology, covering its definition, historical context, and key principles, including risk assessment. Students will gain proficiency in classifying toxic substances, understanding exposure routes, and exploring environmental fate and transport, including bioaccumulation processes. Emphasis is placed on ecotoxicology, biodiversity impact, and practical skills in analytical techniques for environmental monitoring. The curriculum also addresses human health implications, regulatory frameworks, and emerging issues like nanotoxicology and endocrine-disrupting chemicals, offering a well-rounded perspective on environmental toxicology.						

Course Outcomes

CO1	Have an enhanced knowledge of Toxicology and environmental policy
CO2	Be able to understand the properties of toxic substances
CO3	To know about the environmental toxicant spread in air, water, and soil
CO4	Be able to explain the impact of toxicants on the ecosystem, biodiversity, Human health, and conservation strategies and techniques
CO5	Be able to describe Environmental Nanotoxicology.

Unit No.	**Title of theUnit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Environmental Toxicology	Definition, scope, and significance of environmental toxicology, Historical perspective, and key milestones, Basic principles of toxicology, and risk assessment	6	CO1
2	Fundamentals, Fate and Transport of Toxicants	Classification of toxic substances: chemical, biological, and physical agents, Routes of exposure and mechanisms of toxicity, Dose-response relationships, and factors influencing toxicity. Environmental distribution of toxicants (air, water, soil), Bioaccumulation and biomagnification processes, Fate and transport models in environmental toxicology	8	CO2
3	Ecotoxicology and Biodiversity	Impact of toxicants on ecosystems and biodiversity, Case studies of environmental disasters and their ecological consequences, Conservation strategies, and ecotoxicological risk assessment	8	CO4
4	Human Health and Environmental Toxicology	Human exposure to environmental toxins, Health effects of common environmental pollutants Risk communication and management in public health	8	CO4
5	Regulatory Framework and Environmental Policy	Overview of environmental regulations related to toxic substances, International and national regulatory agencies, Case studies on successful toxicology-based policy implementations	8	CO1
6	Emerging Issues and Analytical Techniques	Nanotoxicology and its implications, Endocrine-disrupting chemicals, Global challenges and future trends in environmental toxicology. Instrumental techniques: chromatography, mass spectrometry, etc. Biomarkers and bioassays for environmental monitoring	7	CO5

Reference Books:

1-Anisa Basheer (1995) Environmental Epidemiology, Rawat Publications, New Delhi.

2-Meera Asthana and Astana D.K (1990) Environmental Pollution and Toxicology, Alka Printers, Chandigarh.

3-Sharma PD, Rastogi and Lamporary (1994) Environmental Biology and Toxicology, Rajpal and Sons Publishing, New Delhi.

4-Sood A (1999) Toxicology, Sarup and Sons, New Delhi.Toxicology, Biochemistry and Pathology of Mycotoxins, by Kenji Uroguchi a mikio, Yamazadi Kodanshoa Ltd.,Tokyo, 1978.

e-Learning Source:

https://www.youtube.com/results?search_query=Environmental+Toxicology

https://www.youtube.com/watch?v=RNNjN065y5o

https://www.youtube.com/watch?v=v4jmPpTcdxQ

https://www.youtube.com/watch?v=-u3sHVjd-So

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	2	2	1	2	2	-	-	-	-	2	2	1	1	3	-
CO2	2	1	1	1	2	2	2	2	-	-	-	-	1	3	1	1	3	-
CO3	2	2	2	2	2	2	2	2	-	-	-	-	1	2	1	1	3	-
CO4	1	1	1	1	1	2	2	1	-	-	-	-	1	2	1	1	3	-
CO5	1	1	1	2	2	2	2	1	-	-	-	-	1	2	1	1	3	-

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Department of Environmental Science
Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	**ES 423**	**Title of the Course**	**Environmental Economics**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	II	2	1	0	3
Pre-Requisite	B.Sc. Environmental Science	**Co-requisite**					
Course Objectives	The purpose of this course is to impart basic and key knowledge of Environmental Impact and Risk Assessment. This will help in enhancing knowledge of the Environmental Impact Assessment Process, methodologies of Environmental Impact Assessment and Risk assessment. After completing of course, the student will be able to explore the subject in their respective dimensions.						

Course Outcomes

CO1	Students will be able to Analyse the role of ecological economics in influencing demand and Supply in Markets and environmental policy.
CO2	Students will be able to Evaluate costs and benefits of pollution control by adopting market-based instruments for controlling Environmental pollution.
CO3	Create an Understanding among Students about how guiding principles of Sustainable developmental help in facing global challenges of Sustainable Development
CO4	Students will be able to Analyse importance of strategies of global sustainability in developing instruments for implementing Sustainability.
CO5	Knowledge related to Environmental Policies and Economic Solutions etc

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Ecological Economics	Scope and Importance of Ecological Economics, Economics and Environmental Policy, the market mechanisms and choices, benefits of Environmental protection: Demand and supply, market Price and Quality: Environmental Externalities and the problem of Social cost. Valuation of Ecosystem services, Value Addition in Agriculture Crops, and Agricultural Marketing.	7	CO1
2	Ecological Cost Benefits and Environmental Protection	Economic Analysis of Climate change, Benefits of Controlling of Green House Gasses, Cost of Controlling Green House Gasses, Carbon Trading and CDM mechanisms. Measuring the Cost and Benefits of Pollution control, Economic Principles of Cost Benefit Analysis, Measurement of Economic Value of the Environment, Integrated Environmental accounting, Green Accounting.	8	CO2
3	Economic Sustainability	Definition and Dimensions of Sustainability, Global Challenges of Sustainable Development, The Ecological Footprint, Global Environmental Monitoring and Assessment, Guiding Principles of Sustainable Development, National Sustainable Development Strategies, Sustainability Indicators, Environmental Sustainability Index, Global Action and Sustainable Development, Education for Sustainability.	8	CO3
4	Economic Solutions to Environmental Programs	Social Cost and Benefits of Environmental Programmes, Marginal Social Cost of Abatement, pollution control, Policies for Controlling Air and Water Pollution, Disposal of Toxic and Hazardous Waste –Standards vz. emission charges, environmental subsidies, polluter pays principle, and pollution permit Trading system.	6	CO2
5	Environmental Policies	Basic Approach to Environmental Policy, Problem of Pollution Control. Moral suasion, Direct control Economic Solutions, policy instruments and environmental markets, environmental market-based instruments: pollution charge, subsidy, deposit refund system, and pollution permit trading system; scenario of the environmental market worldwide ¬ Economic analysis – present value, future value, inflation correction; comparing environmental benefits and costs.	8	CO5
6	Economic Solution	Economic Solutions, policy instruments, and environmental markets, environmental market-based instruments: pollution charge, subsidy, deposit refund system and pollution permit trading system; scenario of the environmental market worldwide ¬ Economic analysis vis-à-vis benefit-cost analysis in environmental decision making – present value, future value, inflation correction; comparing environmental benefits and cost, , water quality regulation, solid and toxic waste regulation	8	CO5

Reference Books:

1- Bhattacharya, R.N. 2001.An Economic perspective , Oxford University Press.

2.-Environmental Economics and Sustainability, Jose G Varghas- Hernandes, Monowar Alam Khalid. Pawan Kumar Bharti, 2018. Discovery Publishing House Pvt. Ltd. ISBN 978-93-86841-37-7 Pg 202.

3-Hanley, Nick and Roberts C.J.2002, Issues in Environmental Economics, Black well Publishers, U.K

4-Ward F. A. 2006,Environmental and Natural Resource Economics, Pearson Prentice Hall, New Jersey.

e-Learning Source:

1-https://www.soas.ac.uk/cedep-demos/000_P570_IEEP_K3736-Demo/module/pdfs/p570_unit_01.pdf

2-https://www.sfu.ca/~wainwrig/Econ400/documents/Econ_460_Lecture-Notes-part_One-10-3.pdf

3- https://ocw.mit.edu/courses/economics/14-42-environmental-policy-and-economics-spring-2011/lecture-notes/

4- https://nptel.ac.in/courses/109107171/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	2	1	1	1	3	-	-	-	-	-	3	1	3	2	2	-
CO2	3	1	2	1	2	3	3	-	-	-	-	-	3	1	3	2	2	-
CO3	3	1	2	1	2	3	3	-	-	-	-	-	3	1	3	2	2	-
CO4	3	1	2	1	3	3	3	-	-	-	-	-	3	1	3	2	2	-

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2024-2025							
Course Code	**ES 424**	**Title of the Course**	**Environmental Management and Planning**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite		**Co-requisite**					
Course Objectives	This course provides an overview of environmental management systems (EMS) and how EMS can support environmental improvements at facilities that are subject to environmental regulations. This course also provides a brief introduction of all, the ISO series. This course explores environmental management from the perspectives of government regulators, private corporations, and non-profit organizations. It emphasizes the interactions among the public, private, and non-profit spheres of activity.						

Course Outcomes	
CO1	Acquire information of social and environmental developments given existing policies that help in decision-making about the future state of resources.
CO2	Be capable of identifying and managing the environmental aspects and help in the establishment of environmental objectives, targets and improvement plans.
CO3	Be able to evaluate of the benefits and principles of an Environmental Management System (EMS), have the ability to understand the complex interface between social and environmental systems and bring together information from social, natural and legal sciences in authorship.
CO4	Be able to explain the commitments and requirements of ISO 14001 from implementation and auditing perspectives, as well as implementation practices
CO5	Be capable of critically evaluating the resource and environmental policy in terms of environmental goals, and social and environmental outcomes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to ISO series	Overview of ISO series; Quality Management ISO 9001; Energy Management ISO 50001; Sustainable Events Management ISO 20121; Eco-Management and Audit scheme EMAS; Environmental Management ISO 14001; Health and Safety BS OHSAS 18001 and Social Responsibility ISO 26000	8	CO1
2	Environmental Management ISO 14001	Identification of environmental aspects and impacts and control of significant environmental aspects, risk evaluation. Defining the purpose and structure of the EMS Standards ISO 14001.	8	CO2
3	Planning & Implementation	Introduction and development of ISO 14001 and its requirements; Eco-Management and Audit Regulation (EMAR); Integration with other management systems; EMS Models	7	CO4
4	Audit monitoring and Policies	The ISO 14001 Seventeen Elements; Planning the EMS implementation Programme: Timescales and resources; Gaining management commitment; Environmental performance measures. Establishing policy and setting objectives and targets; Documentation, monitoring and auditing for improvement.	8	CO3 &5
5	Environment Management System	Establishment and implementation of the EMS; Implementation Issues; Levels of EMS Implementation; Management Review; Accreditation and certification activities; monitoring, review and improvement of an audit program.	8	CO4
6	Resource Recovery	Recycling of wastes, concepts of Life Cycle Analysis (LCA), Eco-Labelling, Carbon trading, Renewable and Non-Renewable energy resources.	6	CO3& 5

Reference Books:

1. Environmental Management, Text and Cases, Bala Krishnamoorthy, PHH Publication, 2 nd Edition, New Delhi, 2009
2. Green Management, Theory & Applications, Karpagam & Jaikumar, Ane Books Pvt. Limited, New Delhi, 2010
3. Green Economics: In theory and practices, Hanley, Shogren and White, Ane Books Pvt. Limited, New Delhi, 2009
4. Environmental Management. Kulkarni, V. and Ramachandra, T.V. Capitol Pub. Co., New Delhi. 2006.
5. The Global Environment in the Twenty-First Century - Prospects for International Co-operation, Chasek, P. S., Indian Reprint by Manas Publications, New Delhi.2004.
6. Introduction to Environmental Management, M.K Theodore & Louis Theodore, CRC Press, Distributors; Ane Books Pvt. Ltd

e-Learning Source:

https://www.youtube.com/watch?v=FGjCZ8M8U_Q&ab_channel=EnvironmentalScienceForCSS
https://www.youtube.com/watch?v=ELuUBl_dOWg&ab_channel=HSESTUDYGUIDE
https://www.youtube.com/watch?v=EQwKZY_CK8Q&ab_channel=Enterclimate
https://www.youtube.com/watch?v=EQwKZY_CK8Q&ab_channel=Enterclimate

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	2	2	2	--	--	--	--	--	2	2	2	2	3	--
CO2	2	2	3	2	--	3	2	--	--	--	--	--	3	3	3	2	--	--
CO3	3	2	2	2	2	2	3	--	--	--	--	--	2	2	--	2	2	--
CO4	1	--	2	2	3	3	--	--	--	--	--	--	2	2	2	1	2	--
CO5	2	3	2	2	2	2	3	--	--	--	--	--	3	3	2	2	2	--

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**