Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2025-2026							
Course Code	**ES511**	**Title o f the Course**	**Environmental Laws, Conventions & Organizations**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**3**	**1**	**0**	**4**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	To study the Environmental protection. To study Environmental laws in India. To study the guidelines and rules for Environmental Protection. To study the importance of Environmental planning. To study major initiatives and policies from Ministry of Environment and Forests.						

Course Outcome	
CO1	Student will be able to analyze understand and asses the environmental protection.
CO2	Students will be able to explain Environmental laws.
CO3	Student will be able to guidelines and rules for Environmental Protection.
CO4	Student will be able to analyze about importance of Environmental planning.
CO5	Student will be able to analyze major initiatives and policies from the Ministry of Environment and Forests.

Unit No.	Title of the Unit	Content of Unit	Contac tHrs.	Mappe dCO
1	**History of Environmental Protection in India**	History of environmental law in India, Duties and responsibilities of citizens for environmental protection, Subjects related to the environment in the seventh schedule of the Constitution: Union list, State list and Common or Concurrent list, Scheme of labeling of environmentally friendly products (eco-mark), Environmental Information Systems	08	CO1
2	**Environmental Laws in India (Application in current scenario)**	Legal control of Environmental pollution in India with special reference to the Environment (Protection) Act 1986, Powers of Central Government under EPA, The Water (Prevention and Control of Pollution) Act 1974.	06	CO2
3	**Environmental Acts inIndia (Application in current scenario)**	A i r (Prevention and Control of Pollution) Act 1981, Forest Conservation Act 1980, Wildlife (Protection) Act 1972, Public Liability Insurance Act 1991, National Environment Appellate Authority Act 1997, The National Green Tribunal Act 2010.	08	CO2
4	**Solid and Hazardous Waste Rules**	Biomedical Waste Act/rule-2004, Waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998. Manufacture, storage, and import of Hazardous Chemical Rules, 1989. Case studies. The Biomedical Waste (Management and Handling) Rules 1998. The Ozone Depleting Substances (Regulation and Control) Rule 2000.	06	CO 3
5	**Recent Acts India.**	Environment (Protection) Amendment Rules, 2022, The Noise Pollution (Regulation and Control) (Amendment) Rules, 2010.Plastic Ban rules, E-Waste rules .	08	CO4
6	**Major Initiatives/Policies from MoEF**	National Ganga River Basin Authority, Ganga Action Plan Phase I and II, Namami Gangey-National Mission for Clean Ganga, National Green Tribunal, Capacity Building for Industrial Pollution Management, National Environmental Protection Authority, Green India, Mission Environmental Clearances: National Environmental Assessment and Monitoring Authority.	08	CO5
7	**International Conventions and Policies**	International Environmental Laws: Evolution and development of International Environmental laws. Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle, Public Trust Doctrine. Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Basel Convention (1989, 1992), Earth Summit, 1992, 2002, Kyoto Protocol, 1997 and Cartagena Protocol on Biosafety. Convention on Biological Diversity, 1992	08	CO5
8	**National and International Agencies for Environmental Justice**	Government Bodies related to environment conservation in India, Central Pollution Control Board, National Biodiversity Authority, National Tiger Conservation Authority, Animal Welfare Board of India, Forest Survey of India, and Central Zoo Authority of India. Role of International Environmental Agencies - Food and Agriculture Organization, Global Environment Facility United Nations Convention on the Law of the Sea, International Seabed Authority, International Tribunal for the Law of the Sea, United Nations Convention to Combat Desertification Secretariat United Nations Environment Programme, United Nations Framework Convention on Climate Change Secretariat, World Meteorological Organization	08	CO5

Reference Books

Diwan P (1997) Environmental Administration - Law & Judicial Attitude, Vol. I, II. Deep & Deep Publishers, New Delhi.

Gurudeep Singh (2005) Environmental Law in India, Mc Millan, New Delhi.

Jariwala CM (2000) Complex Enviro-Technoscience Issues. 42 (1), Journal of Indian Law Institute. 29.

Leelakrishnan P (1999) Environmental Law in India. Butterworths Publications, New Delhi.

Naseem M (2011) Environmental Law in India, Wolters Kluwer Law and Business, The Netherlands.

e-Learning Source:

https://www.slideshare.net/kristyawansutriyanto/ppt-environmental-protection

https://www.slideshare.net/HashTagJay/environment-protection-and-fundamental-rights

https://www.slideshare.net/gauravhtandon1/environmental-law-and-regulations-i

https://www.slideshare.net/fdjaipur/environmental-planning-213292282

https://www.slideshare.net/nega2002/government-initiatives

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	1	2	1	2						2	2	1	2	2	
CO2	3	1	1	2	2	1	2						2	2	1	2	2	
CO3	3	2	1	2	2	1	1						3	2	2	1	2	
CO4	3	2	1	2	1	2	2	-	-	-	-	-	3	2	2	2	2	-
CO5	3	1	1	2	2	1	2	-	-	-	-	-	3	2	2	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: 2025-2026							
Course Code	**ES512**	**Title of the Course**	**Waste Management and Circular Economy**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	This course will develop an understanding of different types of Municipal, Industrial, Biomedical, Electronic waste, their sources of generation and their characteristics. Develop the knowledge of sustainable waste management practices from its generation to disposal. Also, this course will impart an understanding of various rules and regulations related to solid waste management.						

Course Outcomes	
CO1	• Identify the different sources of waste in environment.
CO2	• Discuss and critically review the different types of Municipal solid waste and its management.
CO3	• Knowledge to recover energy from waste.
CO4	• Knowledge of hazardous waste and its management.
CO5	• Knowledge of Biomedical waste, E-waste and its managemen.t

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to waste & Circular economy**	Wastes: Introduction, sources, characteristics, composition, and classification, waste generated per capita, Global scenario of wastes. Concept of Circular economy**(ADD)**	5	CO1
2	**Municipal solid waste (MSW):**	Municipal solid waste (MSW): Solid Waste, its definition, sources, classification and composition; physical and chemical characterization of municipal solid waste; Municipal solid waste (MSW): collection, segregation (biodegradable and non-biodegradable), storage, transportation, processing and disposal; MSW landfill site selection, design, operation, maintenance and reclamation. MSW (Management and Handling) Rules in India, future prospective of MSW generation and its management.	8	CO2
3	**Hazardous waste management:**	Hazardous waste management: Definition, sources and characteristics; Categorization and identification of hazardous wastes; Transboundary movement of hazardous waste (Basel Convention) and case studies related to it; Designing of Hazardous waste landfills site selection, operation, maintenance and remediation of hazardous waste disposal sites; Hazardous Waste Management Rules in India.	8	CO3
4	**Biomedical waste management:**	Bio-Medical Waste: categorization, treatment and disposal; Bio-Medical Rules in India; Electrical and electronic waste management and disposal; e-waste rules in India; Nuclear waste and its disposal techniques. Case Studies.	8	CO4
5	**Plastic waste and E-waste management**	Sources, Facts & figures of plastic waste scenarios at the National & International level, Effect of plastic waste on the environment, and Control measures of plastic waste. E-wastes: Sources, types of e-wastes–Impacts of e-wastes in the environment - Control measures of e-wastes.	8	CO5
6.	**Waste to Energy and Integrated Waste Management**	Generation rates and waste composition; Integrated waste management issues, collection, recovery, reuse, recycling, energy-from-waste, and landfilling; Biological treatment of the organic waste fraction - direct l and application, composting, and anaerobic digestion. Waste to Energy: Waste transformation through aerobic, anaerobic composting and Energy recovery (Refuse Derived fuels, Incineration, Pyrolysis, and Plasma Technology); case studies related to it,	8	CO3

Text & References

Bhide, A. D, Sundaresan, B. B., Solid waste management in developing countries, Indian National Scientific Documentation Centre, 1983
Kumar, R and Singh, R.N. Municipal Water and Wastewater Treatment. Capital Pub..Co., New Delhi. 2006.
Noble, G. Sanitary Landfill Design Handbook. Technomic Westport Connecticut, USA. 1976.
Peavey, H. S, Rowe, D. R and Tchobanoglous, G. Environmental Engineering.International Ed. McGraw-Hill, New York, USA. 1985.
Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999.
Tchobanogloas, G. Integrated Solid Waste Management: Engineering, Principle and Management. McGraw Hill, USA. 1993.
Vesilind, P. A., Worrell, W. and Reinhart, D. Solid Waste Engineering. Brooks/ Cole Thomson Learning Inc., USA. 2002.
Sharma B. K., Environmental Chemistry, Goel Publishing House, Meerut, 2011.

e-Learning Source:

• **Virtual Labs** • • **SWAYAM**• **MOOC**

	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	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO2	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO3	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO4	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO5	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-

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

Integral University, Lucknow
Department of Environmental Studies

Effective from Session: 2025-2026							
Course Code	**ES513**	**Title of the Course**	**Remote Sensing, GIS, and its application**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	This course provides students an understanding of the basic concepts of remote sensing and Geographical Information Systems (GIS) techniques and the applications of these techniques in various branches of environmental sciences. The course is organized into two parts. The first part focuses on the theories underlying basic processes in remote sensing, aerial and satellite remote sensing, photo-grammetry, sensors and digital image processing. Students will be taught processing of satellite images, and how data from various satellite platforms are used in the environmental sciences. The second component of the course focuses on the GIS, where the structure and format of GIS data, data input and transformation, spatial analysis are taught. In addition, students will gain an understanding of the recent advances in GIS such as WebGIS, Open Geospatial Consortium (OGC), and data portals commonly used in remote sensing and GIS.						

Course Outcomes	
CO1	Explain basic physical principles of remote sensing
CO2	Understand the concept and foundation of Aerial Photogrammetry.
CO3	Understand the basic difference between various kinds of satellites and sensors.
CO4	Understand image processing technique and its types.
CO5	Explore the GIS technique, GPS, and application in environmental studies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basic Concept**	Remote Sensing: History, Development, Definition, Concept & Principles,Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions, and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Response and Spectral Signature, Spectral, Spatial,Temporal and Radiometric resolutions.	8	CO1
2	**Aerial Remote Sensing**	Aerial Remote Sensing - advantages of aerial remote sensing, elements of photographic systems - films, aerial cameras, filters. Classification of aerial photos and processes of aerial photos, elements of image interpretation, interpretation keys, interpretation of photographs and images for environmental analysis. Photogrammetry – Geometric characteristics of aerial photographs, scale of photographs, stereo models, principles of stereophotos, relief displacement, parallax and measurement of height and slope, convergence and evidence, aerial mosaics, ortho-photos, photogrammetric instruments	7	CO2
3	**Remote Sensing Satellite**	Satellite Remote Sensing - advantages of satellite remote sensing, types of satellite orbits - polar and geostationary, Satellite characteristics - Orbit, swath, resolution, scale. Overview of satellites - Landsat, SPOT, IRS, NOAA, Cartosat, Oceansat, IKONOS, QUICKBIRD, ERS, RADARSAT, INSAT satellites - their sensors, geometry, radiometry, orbital characteristics, data products and applications.	8	CO3
4	**Digital Image Processing**	Digital Image Processing - Digital Image formats, file structures, Image Rectification and Restoration, Image enhancement, Image classification – supervised, unsupervised, ground truth data and training set manipulation, data merging.	6	CO4
5	**GIS**	Geographical Information System (GIS) - definition, historical evolution, components, basic principles. Data models - vector and raster data, spatial and non-spatial data, Map projection, defining spatial relationships, Spatial Analysis, measurements, queries, buffering and neighborhood functions, map overlay, network analysis, spatial interpolation –TIN, DEM, DSM. Advances in GIS – Web GIS, Open Geospatial Consortium (OGC), FOSS in GIS, Data mining, Bhuvan Geoportal.	8	CO5
6	**GPS & Application of Remote Sensing and GIS**	Global Positioning System (GPS) - System segments, GPS satellite signals, GPS error sources, calculating locations, differential GPS and GPS in differential mode, and applications of GPS in environmental studies. IRNSS GPS. Application of Remote Sensing and GIS: Applications in forestry and wild life management; monitoring of land use/land cover; soil and agriculture; water resources; urban planning; disaster management; health studies.	8	CO5

Reference Books:

Abbassi, Er. T. &Abbassi, S.A. 2010. Remote sensing, GIS and Wetland management, Discovery publishing house, Pvt. Ltd.

Agaral, N.K. 2004. Essentials of GPS, Spatial Networks Pvt. Ltd. Hyderabad.

AnjiReddi, M. 2000. Remote Sensing and geographical Information System.

Lillesand, T. M. and Kiefer, R. W. 1987.Remote Sensing and Image Interpretation. John Wiley and Sons, New York.

Cracknell, A. P. &Varotsos, C. A. 2012.Remote sensing and atmospheric ozone-Human activities versus natural variability, Springer, published in association with Praxis Publishing, Chichetser, UK

e-Learning Source:

www.aboutgis.com

www.bhuvan.nrsc.gov.in

www.surveyofindia.gov.in

www.esri.com

	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	PSO4	PSO5	PSO6	PSO7
CO1	2	2	2	2	2	2	2	2					2	3	1	1		
CO2	2	2	2	2	2	2	2	2					2	3	1	1		
CO3	3	2	2	2	2	2	2	2					2	3	2	2		
CO4	3	3	2	2	3	2	2	2					2	3	2	2		
CO5	3	3	3	3	3	3	3	3					1	2	2	2		

1- 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: 2025-2026							
Course Code	**ES514**	**Title of the Course**	**Apprenticeship/ Internship**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	III	**0**	**0**	**3**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	Upon finishing the course students will be able to come up with a gain of professional work in industry and research project experience and develop practical skills in environmental monitoring, assessment, and management.						

Course Outcomes	
CO1	To apply theoretical concepts learned in degree coursework 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)
CO4	Skills in Environmental Management and Policy.
CO5	Analytical and Research Skills.

Unit No.	**Title of the Unit**	**Content of unit**	**Mapped CO**
1	Internship/Apprenticeship (Research Project I)	Students are encouraged to undergo summer/winter in plant training in a suitable industry, consultancy, research laboratory, institute, Protected Areas etc. so as to get firsthand experience of corporate environmental management and of natural habitat . Candidates will write a field project report on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The field project must consist of a review of the literature and produce a deep insight of the subject based on personal research. Field project work will be initiated at the start of Semester. The students will undertake fieldwork in terms of the collection of data and surveys. The field project will have to be submitted for appraisal and acceptance by the University. The students should submit their field project report 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 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 should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their field project report one month Before the practical examination at the end of Semester. The field work report will carry 100 marks (Internal marks 20 and External marks 80). Assessment of the report will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the field work shall be done by the external examiner appointed by HOD, Integral University.	CO1,2,3,

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO5	PSO6
CO1	2	2	2	1			1			2	1		1	2		
CO2	3	2	1	1					1		1		1	1		
CO3	3	2	2	2	2	2					2		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: 2025-2026							
Course Code	**ES515**	**Title of the Course**	**Environment Impact Assessment and Auditing**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	2	0	1	3
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	The purpose of this course is to impart basic and key knowledge of Environmental Impact Assessment. This will help in enhancing knowledge of the Environmental Impact Assessment process, legislations, Environmental clearance procedure for Projects, Environmental Impact Assessment methodologies, Environmental Auditing, monitoring and ISO standards and gaining practical knowledge through Case studies. After successfully completing of course, the student will able to explore subject into their respective dimensions.						

Course Outcomes	
CO1	Students will be able to get basic knowledge about Environmental Impact Assessment and its process and clearance
CO2	Students will be able to evaluate the role of Environmental Impact Assessment methodologies in the Environmental Impact Assessment Process.
CO3	Students will be able to evaluate the Importance of methods and tools for EIA.
CO4	Students will be able to analyze role of Environmental Auditing, monitoring and ISO standards in Environmental Impact Assessment.
CO5	Students will be able to get practical knowledge through observation of Case studies related to EIA.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction and Background**	EIA, Requirement of EIA in India,, scope and purpose of EIA; EIA process, Salient features of EIA legislation and otherstatutory obligations, Environmental decision making in India: Environmental clearance procedures and national requirements.	9	CO1
2	**Assessment Framework**	Methodological approaches and tools for key stages in EIA process: Screening (stage to determine the level of EIA, exclusion and inclusion criteria of projects, different approaches to screening) Scoping (scoping steps, guidance and tools, and stakeholder involvement), Impact prediction and evaluation (approach for baseline development and methods of impact identification-checklists, Matrices, Networks)	9	CO2
3	**Methods and Tools For EIA**	Introduction to various impact assessment methods: checklist, matrices, networks, indices and weight scaling techniques; their scope and limitations, Prediction and assessment of impact on the land, air, water, noise, biological and socioeconomic environments Mitigation: definitions measures including avoidance, reduction, rectification and compensation approaches, principles and concepts of offsets, type of offsets.	9	CO2
4	**Environmental Auditing Monitoring & ISO Standards**	Objectives and usefulness of Auditing, Attributes of an auditor and psychology of auditing, monitoring; EIA Types (monitoring, Baseline monitoring,Compliance monitoring; Mitigation monitoring), Ex ante and Post ante EIAs, introduction to national accreditation scheme, ISO 9001, EMS and its benefits, ISO 14001, explanation of PDCA cycle	9	CO4
5	**Practical Observation through Case Studies**	Case studies of hydropower, Cement industries, and thermal projects.	9	CO5

Reference Books:

1.Bregman JI (1999) Environmental Impact Statements. Lewis Publishers, London

2.Canter LW (1996) Environmental Impact Assessment. Mc Graw Hill, New York.

e-Learning Source:

1. http://www.fao.org/3/i2802e/i2802e.pdf
2. http://www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf
3. http://extwprlegs1.fao.org/docs/pdf/ind4656.pdf
4. http://awsassets.wwfindia.org/downloads/session

	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	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	1	1	2	2	3	-	-	-	-	1	2	3	-	-	-
CO2	3	1	1	1	1	2	2	3	-	-	-	-	1	2	3	-	-	-
CO3	3	1	1	1	1	2	2	3	-	-	-	-	1	2	3	-	-	-
CO4	3	1	2	2	1	2	2	3	-	-	-	-	1	2	3	-	-	-
CO5	3	1	2	1	1	2	2	3	-	-	-	-	1	2	3	-	-	-

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: 2025-2026							
Course Code	**ES516**	**Title of the Course**	**AI and Environment**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	The curriculum aims to provide environmental sciences students with the knowledge and skills to leverage artificial intelligence for advanced research, monitoring, and sustainable management of environmental resources. It's designed to address the growing demand for individuals with an understanding of both our changing climate and artificial intelligence, together with the business acumen to deploy that understanding effectively.						

Course Outcomes	
CO1	Understand the concept of Artificial Intelligence (AI) and identify tools and algorithms appropriate for different applications
CO2	Gain insight into different application areas for AI and their different challenges
CO3	Describe pressing societal and environmental challenges, where AI has been successfully deployed to tackle them
CO4	Represent knowledge using formal logic and design algorithms to work in a semi-observable environment using logical reasoning.
CO5	Implement probabilistic reasoning techniques to work in uncertain environments.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Artificial Intelligence**	History and evolution of AI, comparison of human and computer skills, Component of AI, Scope and significance in different domains, Ethical considerations in AI development and deployment, Intelligent Agent, logical agent. Problem-solving through AI: Defining the problem as a state space search, analyzing the problem, solving the problem by searching, informed search, and Uninformed Search	6	CO1 &2
2	**Machine Learning Basics**	Neural networks and deep learning, Supervised and unsupervised learning, Feature selection and engineering, learning from observation, and knowledge in learning. Natural Language Processing: Brief history of NLP, Text processing, Sentiment analysis, language translation, Early NLP system, ELIZA system, LUNAR system, General NLP system.	6	CO2 & CO5
3	**Applications of AI & ML in the Environment**	Using AI 'guardians' to save trees, reduce the carbon footprint of steel and energy waste reduction, Tackle poaching, smart agriculture, plotting clouds using computers, environmental sustainability (biodiversity, climate, water, forests), disasters, and climate change. Artificial intelligence its role in environmental research, Ethical considerations, and environmental sustainability in AI applications.	8	CO2 & 3
4	**Remote Sensing and Image Analysis with AI**	AI applications in analyzing satellite and aerial imagery, Image classification and feature extraction, Monitoring land use, vegetation, and environmental changes, Environmental Data Analysis and Modeling: Handling and preprocessing g of environmental data, Predictive modeling for climate patterns and ecological systems, Time series analysis for environmental monitoring	8	CO3
5	**AI for Biodiversity Conservation**	Machine learning applications in analyzing biodiversity data, Predictive modeling of species distribution, Conservation strategies and ecological impact assessment with AI, Using AI to enhance climate modeling, Predictive modeling for climate change impacts, Simulation, and scenario analysis with machine learning	8	CO 2,3,4 &5
6	**Water Resources Management with AI**	AI applications in analyzing water quality and availability, Predictive modeling for water resource management, Optimization algorithms for sustainable water usage, Using AI to address environmental sustainability challenges, Analyzing and mitigating environmental impacts of AI technologies, Implementing AI for sustainable development goals, Predictive modeling for policy impact assessment, AI applications in environmental risk assessment, Decision support systems for environmental policies	9	CO 2,3,4 &5

Reference Books:

A Large-Scale Study on Predicting and Contextualizing Building Energy Usage . J. Zico Kolter, Joseph Ferreira. AAAI 2011

A Machine Learning Approach to Modeling Human Migration. Caleb Robinson and Bistra Dilkina. ACM SIGCAS Conference on Computing and Sustainable Societies 2018

"Adversary models account for imperfect crime data: Forecasting and planning against real-world poachers." Gholami, Shahrzad, et al. AAMAS 2018.

"Efficient sensor placement optimization for securing large water distribution networks." Krause, A. et al. Journal of Water Resources Planning and Management, 2008

Deb, Kalyanmoy. "Multi-objective optimization using evolutionary algorithms: an introduction." Multi-objective evolutionary optimisation for product design and manufacturing. Springer, London, 2011. Available at: https://link.springer.com/chapter/10.1007/978-0-85729-652-8_1

Environment Impact Assessment Guidelines, Notification of Government of India, 2006.

Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

e-Learning Source:

SWAYAM, MOOC, e-Skill India

"Artificial intelligence for social good: A survey." Shi, Zheyuan Ryan, Claire Wang, and Fei Fang. arXiv preprint arXiv:2001.01818 (2020).

Analysis: Basic Concepts and Algorithms [can be downloaded at: http://www-users.cs.umn.edu/~kumar/dmbook/ch8.pdf], ISLR Ch. 10

Tutorials: https://dssg.github.io/fairness_tutorial/, https://www.borealisai.com/en/blog/tutorial1-bias-and-fairness-ai/

• "Why Should I Trust You?": Explaining the Predictions of Any Classifier. Marco Tulio Ribeiro, Sameer Singh, Carlos Guestrin. In KDD, 2016

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1		2			2		3				3		2
CO2	3		2					2	3	2		2	
CO3	2				2			2					2
CO4			3			2		2			2	3	
CO5	3				3	2					3		3

1- 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: **2025-2026**							
Course Code	**ES 517**	**Title of the Course**	**Public Health Emergency and Disaster Management**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	This course provides an introduction to different types of public health and environmental health disasters, their consequences, and the role of public health agencies and practitioners in preparedness, response, and recovery. The course will employ an all-hazards, domestic perspective, and explore different types of natural, biological, chemical, radiological, nuclear, and other human-caused disasters. Through course lectures and readings, case studies, discussion, and debate, students will learn and understand the foundational concepts of the public and environmental health community's role in preparing for, responding to, and recovering from disasters. The course we will be discussing personal and hospital-based preparedness for disasters and large-scale public health emergencies. This course will provide students with a heightened awareness and understanding of the natural and man-made hazards that create disaster events.						

Course Outcomes	
CO1	Describe types of disasters and their public health consequences
CO2	Identify the key stakeholders involved in preparedness and understand the policy, legal and ethical frameworks for public health preparedness.
CO3	Explain the role of environmental health and other public health practitioners in an emergency and evaluate strengths and gaps in the preparedness system and suggest methods for improvement.
CO4	Synthesize information to identify a scientific problem associated with disaster preparedness.
CO5	Propose a methodological approach to address a disaster preparedness-related scientific problem within realistic time and resource constraints.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Disasters & Epidemiologic Response to Disasters**	Definition; Significance; Factors of disaster risk; Disaster Risk analysis (with special reference to the Indian context) – Inter-relationship between Hazard, Vulnerability, and Disaster Risk; Global disaster risk situation; Disaster risk situation of India; Hazard-Vulnerability maps of India; Public Health Implications of Disasters and Hazards and its Impacts, Differential impacts- in terms of caste, class, gender, age, location, disability. Global trends in disasters-urban disasters, pandemics, complex emergencies, climate change. Disaster profile of India. The Role of Disaster Epidemiology in Disaster Preparedness and Response	07	CO1
2	**Overview of Public Health Emergency Preparedness and Response**	An Overview of Disaster Management, Health Emergency Risk Management Health Emergency Management Capacity & Capacity assessment, Health Planning for Emergencies, Risk Communication, Mass Casualty Preparedness plan, Hospital Emergency Operations Plan, Management of Civilian Casualties, Mass Casualty Ambulance/Management, Pre-hospital Care, Management of Chronic Diseases following Disasters, Disaster Management Centre	07	CO2
3	**Community Health Aspect Preparedness and Response**	Medico-Legal Aspects of Disasters, Sociological Aspects of Disasters, Environmental health and managing displaced people following disasters, Reproductive Health in Emergencies, Control of Communicable & Non-Communicable diseases in Disasters, Nutrition in Emergencies, Engineering Aspects of Disasters, Disastrous Conditions in Animals, Monitoring & Prevention of occurrence of disaster, Understanding Community Needs Before, During and After Disaster	07	CO3
4	**Disaster-related Morbidity and Mortality Surveillance Methods**	Overview of Disaster Surveillance, importance of disaster surveillance, objectives of disaster surveillance, challenges in establishing a surveillance system during a disaster, disaster surveillance: morbidity and mortality considerations, planning and step for disaster surveillance, Disaster Surveillance Methods: Active and Passive, Disaster-related Morbidity and Mortality Surveillance Indicators and data collection forms, Laws and Policies that Support Public Health Emergency Preparedness and Response	08	CO4
5	**Disaster Preparedness**	Introduction to Disaster Preparedness, Basic Foundational Concepts of Disaster Preparedness, Incident Command System and Leadership at the Unit Level, Disaster Communication and Situational Awareness, Establishing Personal and Family Preparedness. Hospital Preparedness Overview, Creating Surge Capacity (Lifeboat Ethics), Disaster and Mass Casualty Triage, Workforce Readiness and Willingness to Respond Disaster Drills	08	CO 3,4 &5
6	**Disaster Preparedness for the Health Care Professional**	Chemical and Radiation Events: Chemical Emergencies, Radiation Emergency Management Overview, Responding to Radiation Events, Use of Personal Protective Equipment Decontamination. Pandemic Influenza and Emerging Infections: Surge Capacity Management During an Infectious Disease Outbreak, Seasonal and Pandemic Influenza, Responding to Emerging Infectious Disease Outbreaks, Disease Containment Strategies, and Protective Equipment for Safety During Infectious Disease Outbreaks Natural Disasters: Planning for Natural Disasters, Activation of the Hospital EOC in Response to Natural Disasters, Morbidity and Mortality Related to Natural Disasters, Advancing the Science: Current Research Efforts, Q and A "Ask Us Anything"	08	CO5

Reference Books:

1. Cutter, L.1999. Environment risks and hazards. Prentice Hall of India Private Limited, New Delhi
2. Disaster Management in India – A Status Report. National Disaster Management Division, Ministry of Home Affairs, Govt. of India
3. Jacobsen Introduction to Global Health [Elektronisk resurs] Jones and Bartlett Learning, 2018 LIBRIS-ID:22540864
4. Howard, Natasha; Sondorp, Egbert; Veen, Annemarie ter Conflict and health, Maidenhead, Berkshire, England : McGraw Hill/Open University Press, 2012. - xvii, 197 pages ISBN:9780335243792 (pbk.)
5. Humanitarian needs assessment: the good enough guide,Rugby : Practical Action Publishing, [2014] - xi, 108 pages ISBN:9781853398636
6. Eriksson, Anneli Estimating needs in disasters, University of Bergen, 2020 p. 17-29
7. Cuesta, Gil Improving the evidence base of health interventions in humanitarian crises, University of Antwerp, Faculty of Medicine and Health Sciences, 2020 p. 29 - 82

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	PSO4	PSO5	PSO6	PSO7
CO1	1	2		1	2		3	1		1	3	1	2
CO2	3		2	1				2	3	2		2	
CO3	2			1	2		1	2	1	1	1	1	2
CO4			3	1		2		2			2	3	
CO5	3	1		1	3	2	1		1	1	3		3

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	**ES518**	**Title of the Course**	**Climate Change and Ecosystem Resilience**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	To make students aware of scenario of climate change and to provide exposure on resilience of species in nature.						

Course Outcomes	
CO1	Students will be able to analyse through the study of Elements of Climate, the impact of Human activities on World Climate.
CO2	Students will be able to Analyse the contributions of extreme events of Climate on Earth in bringing about changes in Climate.
CO3	To create knowledge for Global and National Action Plans to combat climate Change Issues.
CO4	Students will be able to evaluate the role of remedial measures in combating Global Warming and Climate Change.
CO5	To create awareness about the role played by remedial measures in assessing the vulnerabilities of natural resources.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Elements and Components of Climate Change	Elements of climate: Temperature, precipitation, atmospheric circulation and atmospheric chemistry. Human activities (Fossil fuel burning, industrial processes, land use), Natural influences (Plate tectonics, orbital cycles, ocean circulation, solar variability).	8	CO1
2	Climate Change and its Impact	Impacts on earth system and society; Impact- regional, national, global; ecosystems; agriculture and food security; sea level rise; acid rain; ocean acidification, coral bleaching; human health; Forestry and Fishery	8	CO2
3	Assessing the impacts and vulnerabilities	Assessing Impacts and Vulnerabilities: Key concepts of Sensitivity and Vulnerability – Adaptive capacity, Resilience and Coping ranges and Critical Thresholds; Determinants of vulnerability and adaptive capacity, Climate change scenarios and Vulnerability. Indicators of vulnerability and livelihood; Climate sensitivity analysis; Uncertainties in prediction and detection; Vulnerabilities and adaptation practices in forestry, agriculture, soil & land, water resources.	8	CO3
4	Eco-system Resilience	Resilience: Introduction, why resilience, resilience and stability of ecological systems, resilience of terrestrial ecosystems, regime shift, resilience and biodiversity in ecosystem management.	6	CO4
5	Global/National Action Plans to Combat Climate Change Issues	Key steps taken by UNFCCC to combat climate change: Kyoto Protocol – Bali Action Plan 2007 – Cancun Agreements 2010 – Durban outcomes – Doha Climate Gateway 2012 – Warshaw outcomes2013 – Green climate funds – Clean Development Mechanism (CDM).	8	CO3
6	Case Study	Case studies – 1. Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef, 2. Sea otters and kelp forests in Alaska: generality and variation in a community ecological paradigm.	7	CO5

Reference Books:

1. Barrie Pittock A (2009) Climate Change: The Science
2. Botkin DB (1989) Changing the Global Environment
3. Cowie J (2007) Climate Change: Biological and Human Aspects
4. Dogra N Srivastava S (2012) Climate Change & Disease Dynamics in India
5. Filho WL (2012)

e-Learning Source:

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/119106008/lec40.pdf
http://www.fao.org/3/CA2607EN/ca2607en.pdf
http://moef.gov.in/wp-content/uploads/2019/08/Annual-Report-2018-19-English.pdf

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

1- 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: 2025-2026							
Course Code	**ES519**	**Title of the Course**	**Energy Management and CDM**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**III**	**3**	**1**	**0**	**4**
Pre-Requisite	**Basic in science**	**Co-requisite**					
Course Objectives	The course is a comprehensive adaptation of the goals of Education 4.0. Disruptive Smart Green Technologies summarizes all the importance and the underlying principles of green and sustainable technology. To train students to become the new age researchers and technological experts in natural resource management, Natural Catastrophe Analyst, Risk Assessment analyst, GIS consultants etc.and higher studies.						

Course Outcomes	
CO1	• Knowledge on the importance and significance of green technology
CO2	• Knowledge on the development and application of innovative technologies in the conversion of natural forms of energy to economically and environmentally feasible forms
CO3	• Ability to develop, fabricate and utilize eco-friendly and cost-effective products in a variety of applications, and green design in building and infrastructure
CO4	• Ability to understand the role of green technology in resource generation, employment and improvement of livelihood standards
CO5	• Knowledge of various environmental monitoring and assessment tools, and industrial safety and hazard analysis

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**History and concept**	Introduction: History, concept, and current scenario of green technology; green technology and sustainability. Introduction to Disruptive technology, Innovator's dilemma, 80:20 rule, Technology life cycle.	6	CO1
2	**CDM & Ecofriendly Technologies**	CDM, Development, fabrication and various applications of eco-friendly biosensors, nanomaterials, biopolymers, biogas, bioethanol and biofuel Development and application of eco-friendly and cost-effective tools in environmental pollution management and agricultural activities, Green design, building and infrastructure, Software for environmental assessment	8	CO2
3	**Role of Information technology in Environmental awareness**	Social media tools as disruptive technology, Awareness through social media, Role of social media, Environmental models	6	CO3 CO5
4	**Advantages and disadvantages**	Advantages of green technologies, Disadvantages of disruptive technology Role of green technologies in resource generation, employment and improvement of livelihood standards.	8	CO4
5	**Assessment Techniques**	Life cycle assessment (LCA), life cycle costing (LCC), material flow analysis (MFA), cost benefit analysis (CBA), cost-effective analysis (CEA), carbon footprint, ecological footprint, and eco-labelling.	8	CO5
6	**Solar Thermal Energy Systems**	Basic of thermal sciences, Methodologies for Solar Thermal Conversion System, Solar Thermal Conversion Coating, Coating technology, General description of solar thermal collectors – Flat plate collectors, Concentrating collectors, various types of solar collectors, Performance of solar collectors, Active and Passive heating, Solar cooling.	8	CO1
7	**Bio Energy systems**	Biomass resource assessment, properties of biomass, different energy conversion method combustion, gasification, pyrolysis, liquification, biomass pre-treatment and processing, Bio methanation technology, case studies.	8	CO4
8	**Wind Energy Systems**	Wind Energy conversion principles, General introduction, types and classification of WECS, Power, Torque Speed Characteristics, maximum power coefficient, wind velocity measuring instrument, factors affecting the wind energy output, Principles of wind pump.	8	CO3

Text & References

- Bewick, M.W., 1980. Handbook of organic waste conversion. Van Nostrand Reinhold Co.
- Rai, G.D., 2013. Non-conventional sources of energy. Khanna Publisher
- Kiang, Y.H., 1981. Waste energy utilization technology. United States
- Sanghi, R. and Srivastava, M.M., 2003. Green Chemistry: Environment-Friendly Alternatives. Alpha Science Int'l Ltd.
- Organic Chemistry, L.G. Wade Jr, Pearson Educatio
- Bard, A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, N.
- Electrochemistry of cleaner environments, J OM Bockris , Springer, US.

e-Learning Source:

• **Virtual Labs** • • **SWAYAM**• **MOOC**

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	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO2	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO3	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO4	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-
CO5	2	1	1	1	3	2	1	-	-	-	-	-	3	2	3	2	3	-

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