Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2023-24							
Course Code	**B150501T/ES314**	**Title of the Course**	**Environmental Microbiology and Biotechnology**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	V	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics, Chemistry & Biology	**Co-requisite**	Nil				
Course Objectives	This syllabus provides a comprehensive understanding of environmental microbiology and biotechnology, covering foundational concepts, practical techniques, and real-world applications.						

Course Outcomes

CO1	Get an idea about the historical events in microbiology and biotechnology
CO2	Know concepts related with of microbial ecology and interaction, create a knowledge and understood role of microbes in nutrient cycling, get an idea regarding microbes and their relation with environment
CO3	Know the basic concepts and application of biotechnology in environmental management
CO4	Students will be able to know the molecular techniques involved in environmental microbiology
CO5	Able to explore various uses of microbes for degradation of waste material and ethics in research and application

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Microbiology and Biotechnology	Overview of Microbiology and Biotechnology, Historical development and milestones, Scope and importance in environmental applications	8	CO1
2	Fundamentals of Environmental Microbiology	Microbial diversity in natural environments, Microbial ecology and interactions, Biogeochemical cycles	8	CO2
3	Microbial Physiology and Metabolism	Bacterial structure and function, Metabolic pathways in microorganisms, Microbial growth and control	8	CO2
4	Environmental Biotechnology: Principles and Applications	Basics of biotechnological processes, Applications of biotechnology in environmental management Case studies of successful biotechnological interventions	8	CO3
5	Environmental Microbial Techniques	Sampling and analysis of environmental microorganisms, Microbial identification methods, Molecular techniques in environmental microbiology	8	CO4
6	Bioremediation and Waste Treatment	Principles of bioremediation, Microbial degradation of pollutants, Applications in waste treatment and cleanup	6	CO5
7	Industrial and Agricultural Biotechnology	Microorganisms in industrial processes, Agricultural applications of biotechnology, Genetically modified organisms (GMOs) and their impact	8	CO5
8	Ethical, Legal, and Social Issues in Environmental Biotechnology	Ethical considerations in biotechnological research and applications, Legal frameworks and regulations, public perception and societal impact	6	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.

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc21_ce07/preview
https://archive.nptel.ac.in/content/storage2/courses/pmrf/105107173/noc22-ce15_week2.pdf
https://www.pdfprof.com/PDF_Image.php?idt=7868&t=27
https://www.nitttrc.edu.in/nptel/courses/video/105107173/lec2.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	1	2	2	-	-	-	-	2	1	1	1	2	-
CO2	2	1	1	1	1	2	2	2	-	-	-	-	2	1	1	1	2	-
CO3	2	1	1	1	1	2	2	2	-	-	-	-	2	1	1	1	2	-
CO4	2	1	1	1	1	3	2	2	-	-	-	-	2	3	1	1	2	-
CO5	2	1	1	1	1	3	2	2	-	-	-	-	2	3	1	1	1	-

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: 2023-2024							
Course Code	**B150502P/ ES315**	**Title of the Course**	Environmental microbiology Lab	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	V	**0**	**0**	**2**	**1**
Pre-Requisite	10+2 Physics, chemistry, biology	**Co-requisite**	Nil				
Course Objectives	These lab experiments provide hands-on experience in fundamental techniques of microbiology, allowing students to develop practical skills and understand the relevance of environmental microbiology						

Course Outcomes

CO1	Apply the scientific knowledge to know the rules and regulation while working in lab and the protocol of sterilization of an instrument.
CO2	Develop practical knowledge about difference between prokaryotic and eukaryotic cells
CO3	Gain knowledge about the general instructions, Microbiology laboratory and its discipline
CO4	Develop knowledge of preparation of medium for culture

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	To know the rules and regulation while working in lab and the sterilization techniques of an instrument	15	CO1
2	Study of cell	To observe the difference between prokaryotic and eukaryotic cells	15	CO2
3	Staining techniques	Gram Staining, Fungal Staining	15	CO3
4	Media preparation	Media preparation of culture media,Pouring and Planting Techniques.	15	CO4

Reference Books:

1-Cappuccino, J. C. and Sherman, N. (1992). Microbiology: A laboratory manual, Addison
2-Wesley Pub. Co Benson HJ (1994).

e-Learning Source:

1-chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ijsr.net/archive/v4i11/NOV151021.pdf

2-https://chem.libretexts.org/Courses/Brevard_College/CHE_104%3A_Principles_of_Chemistry_II/07%3A_Acid_and_Base_Equilibria/7.07%3A_pH_Calculations_pH_measurement_and_pH_estimation

3-https://pharmastate.academy/dos-donts-in-microbiology lab/#:~:text=Avoid%20coughing%2C%20sneezing%20and%20yawning,unwanted%20articles%20along%20with%20you.

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**	**1**	**3**	**3**	**2**	**2**						**1**	**3**	**3**	**3**	**3**	-
CO2	**3**	**1**	**2**	**2**	**2**	**3**	**3**						**3**	**2**	**3**	**2**	**1**	-
CO3	**3**	**2**	**3**	**1**	**3**	**2**	**3**						**3**	**3**	**2**	**3**	**2**	-
CO4	**3**	**1**	**2**	**2**	**3**	**2**	**3**						**3**	**2**	**3**	**3**	**2**	-

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: 2023-2024							
Course Code	**B150503T/ ES316**	**Title of the Course**	**Introduction to Physical Environment**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	V	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 Physics, Chemistry, Biology	**Co-reuisite**	Nil				
Course Objectives	Focusing on the basic physics involved in meteorology and its components, the course aims to develop an understanding of biophysics with energy-budget, radiation-physics, and radioactivity perspectives. Relevant topics related to air pollution, energy fluxes, and radioactivity in the environment (including applications) will develop a holistic overview of the physics involved in the environment, thereby enabling students to apply the concepts of physics in identifying and practicing the field of environmental science.						

Course Outcomes	
CO1	Define the core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.
CO2	Conceptualize meteorology and climatology to differentiate them correctly. Know basic atmospheric elements, their function within the climate system, as well as it's physical and chemical characteristics.
CO3	Develop skills and be able to comprehend the physics involved in the ecological structure and functions with an energy perspective;
CO4	Demonstrate knowledge of atmospheric sciences focusing on wind, clouds, precipitation, storms, radiative balance and climatic change;
CO5	Exhibit conceptual skills and demonstrate knowledge of radiation physics and techniques of physics in environmental analysis;

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introductory Meteorology**	Introduction, Importance of Meteorology, Basic Metrics, Scientific Notation, Science of Meteorology. The Atmosphere: Origin of the Earth's Atmosphere, Composition of the Atmosphere, Vertical Structure of the Atmosphere, Ozone Layer, Upper Atmosphere	7	CO1
2	**Physical processes**	The Earth in Space, Earth and Sun, Earth-Sun Relationships, Cause of the Seasons, Solar Energy, Greenhouse Effect, Energy Budget of the Earth	6	CO2
3	**Pressure, Density, and Wind**	Pressure Defined, Measurement of Pressure, Vertical Pressure Gradient, Hydrostatic Approximation, Horizontal Pressure Gradient, Isobars and Wind Speeds, Types of winds and Measurement of Wind, Geostrophic Wind, Gradient Wind, Effect of Friction.	6	CO3
4	**Phases of Water**	Humidity Defined, Capacity and Saturation, Dew Point, Vapor Pressure and the Boiling Point, Humidity Parameters, Measurement of Humidity.	6	CO4
5	**Atmospheric Dynamics**	Atmospheric Stability, Environmental Lapse Rate, Dry Adiabatic Lapse Rate, First Criteria for Stability, Most Adiabatic Lapse Rate, Full Stability Criteria, Inversions and Stability. Clouds and Precipitation, Cloud Microstructure, cloud Measurement, Cloud Classification, Formation of Precipitation, Types of Precipitation.	7	CO5
6	**Atmospheric Circulation**	Atmospheric Circulation Systems, Scales of Atmospheric Motion, Global Scale Circulation, Cyclones and Anticyclones, Monsoon Circulation, Small Scale Circulations, Mid-Latitude Low-Pressure Systems, Air-Masses, Development and Evolution of the Wave Cyclone, Upper Atmosphere.	10	CO5
7	**Measuring Instruments and Techniques**	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, RADARS: the concept of the amplifier, oscillator, receiver, working principle of radar, different types of radar, radar antenna, PPI display, radar network of IMD, components of radar, the function of radar components, Doppler weather radar, Doppler principle.	10	CO5
8	**Analysis and forecast**	Reading a Weather Map, Observation, Analysis and Prediction, Organization of the National Weather Service, Long-Range Forecasts.	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.

e-Learning Source:

MOOC

SWAYAM

Department of Environmental Science
Integral University, Lucknow

	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
CO1	2	1	1	1	1	1	1	3	1	3	1	1	3	3	3
CO2	2	1	2	1	1	1	1	3	1	3	1	1	3	3	2
CO3	2	1	1	1	1	1	1	3	1	2	1	1	3	3	2
CO4	2	1	1	1	1	1	1	3	1	3	1	1	3	3	3
CO5	2	1	1	1	1	1	1	3	1	2	1	1	3	3	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: 2023-2024							
Course Code	**B150504T/ ES317**	**Title of the Course**	**Pollution and Human Health**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Botany, chemistry, physics	**Co-requisite**	Nil				
Course Objectives	This course will enable students to understand environmental problems, looking at causal linkages between pollution sources, exposure pathways and impacts on environmental quality and human health. Students will identify the complex relationships between environmental factors and human health, taking into account multiple pathways and interactions, will be assessed in a broader spatial, socioeconomic, and cultural context. Students will learn how to assess pollution sources, study exposure pathways and fate, and evaluate the consequences of human exposure to pollution and its impacts to environmental quality. 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 understands 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	Student able to learn the concept of radioactive pollution and Pollution control measures.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Environmental Pollution	Definition of pollution; pollutants; classification of pollutants; solubility of pollutants (hydrophilic and lipophilic pollutants), types of environmental pollution., basis and challenges of environmental pollution.	6	CO1
2	Air pollution	Natural and anthropogenic sources, Air borne particles and particulate matters, Temperature inversion, SOX, NOX, Hydrocarbons, Lead & other pollutants; indoor/outdoor air pollution: sources and effects on human health, urban air quality. Impact of air pollutants on plants and materials. Health effects of Air pollution; Adverse health effects of tobacco.	8	CO1
3	Water Pollution	Definition of water pollution, Types of water pollution- physical, chemical, biological and physiological. water quality parameters and standards, Sources of water pollution. Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise, existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones). Effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; Pesticides, oils, greases, organic matters, biodegradation, bioaccumulation and their effects on water bodies	8	CO2
4	Water Treatment Methods and Strategies	Waste waters-domestic, industrial waste waters, their compositions, discharge standards and effects on receiving bodies. Microbiological analysis – MPN. Indian standards for drinking water. Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening.	8	CO3
5	Soil Pollution	Soil formation, inorganic and organic components of soil, soil profile. Soil pollution, Sources- Industrial, Domestic, Agricultural, Factors effecting Soil Quality- Harvesting, Fertilizers and Insecticides & Pesticides. Causes of soil pollution and degradation; Absorption of chemicals and toxic metals by soil and effects. Detrimental effects of soil pollution toxicity, diseases caused, impact on air and water bodies.	8	CO4
6	Noise and Thermal Pollution	Noise Pollution and Thermal Pollution; Sources, weighting networks, Noise exposure levels and standards. Noise control and abatement measures: Impact of noise and vibrations on human health. Control of Noise Pollution: Control of industrial and transport noise at source. Thermal pollution: causes, effects and control measures. Health impact and loss of commodity due to Thermal pollution. Relevant case studies	7	CO4
7	Radioactive pollution	Radioactive pollution: Sources, radioactive elements, concept of radioactivity, radioactive decay and half-life of pollutants, effects of radiation on the surrounding environment, Radioactive waste disposal methods. Effect of radiation on human health (somatic and genetic effects); Nuclear hazards and human health risks (Chernobyl, 3 mile Island, Daiichi- Fukushima).	8	CO5
8	Pollution control	Activated Sludge Process (ASP) - Trickling Filters - oxidation ponds, fluidized bed reactors, concept and working of effluent treatment plants (ETPs).	7	CO5

Reference Books:

1.Khopkar SM (1993) Environmental Pollution Analysis

2.Saxena HM (2011) Environmental Geography

3. Rao CS (1993) Environmental Pollution Control

e-Learning Source:

1-https://www.frontiersin.org/articles/10.3389/fpubh.2020.00014/full

2-https://www.hindawi.com/journals/jeph/2012/341637/

3-https://www.epa.gov/air-quality-management-process/managing-air-quality-human-health-environmental-and-economic

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	PSO6	PSO7
CO1	2	1	1	1									2	2	2	2		
CO2	2	1	1	1									2	2	2	2		
CO3	2	1	1	1									2	2	2	2		
CO4	2	1	1	1									2	2	2	2		

CO5	2	1	1	1									2	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: 2023-24							
Course Code	**ES150505T/ES318**	**Title of the Course**	**Energy and its Management**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	V	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with science	**Co-requisite**	Nil				
Course Objectives	To understand the Introduction and history related to different forms of energy. To provide knowledge of Energy resources and its demand as respect to historical and current perspectives. To develop knowledge of Energy consumption and its impact on environment. To provide knowledge of Policies for uses of energy. To provide deep knowledge of sustainable use of energy.						

Course Outcomes	
CO1	Be able to describe history related to different forms of energy.
CO2	Be able to Illustrate Energy resources and its demand as respect to historical and current perspectives.
CO3	Be able to explain Energy consumption and its impact on environment
CO4	Be able to make connections of Policies for uses of energy
CO5	Have an enhanced knowledge of sustainable use of energy.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Defining energy, forms and importance, energy use from a historical perspectives, Discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, Oil wars in Middle east, advent of nuclear energy, Sources and sinks of energy.	8	CO1
2	Energy resources and Demands	Global energy resources, renewable and non renewable resources, Energy use scenarios in rural and urban setups, Global energy demand, historical and current perspectives, energy demand and use in domestic, industrial, agricultural and transportation sector, generation and utilization in rural and urban environments, energy subsidies and environmental costs.	8	CO2
3	Energy, Ecology and theenvironment	Energy production as driver of environmental change, energy production, transformation and utilization associated environmental impacts (Chernobyl and fukushima nuclear accidents, construction of dams, environmental pollution), energy over consumption and its impacts on the Environment.	8	CO3
4	Politics of energy policy	Political choices in energy policy globally and in the Indian context (Historical and contemporary case studies), domestic and international energy policy, energy diplomacy and bileteral ties of India with its neighbors.	6	CO4
5	Our Energy Future	Current and future energy use patterns in the world and in India, evolution of energy use over time, alternative sources as green energy, need of energy efficiency, energy conservation and sustainability, action strategies for sustainable energy mix and management from a future perspective.	8	CO5
6	Solar Radiation And Its Measurement	Sun as source of energy, nature of its radiation, heat budget of the earth, earth's temperature and atmosphere. Solar radiation measurements.	6	CO1
7	Environmental Aspects Of Energy And Protocols	Concept of sustainable development, Concern over climate change, UNFCC, IPCC, Kyoto protocol: emission trading, Joint implementation, CDM case studies. Environmental policy of the government of India and the working of Ministry of Environment and Forests	8	CO3
8	Ecofriendly Technologies	Various applications of eco-friendly biosensors, 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 .	8	CO5

Reference Books:

1-McK ibbeli, B. 2012.Global Warming's Terrifying New Math, Rolling Stone Magazine.

2-Rowlands, I.H. 2009. Renewable Electricity.'The Prospects for Innovation and Integration in Provincial Policies in Debora L. Van Nijnatteii and Robert Boardmanl (eds), Canadian.

3-Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. l 67-82.

4-Oliver, J. 2013. Dispelling the Myths about Canada's Energy Futilre, Policy: Canadian Politics and Public Policy, June-July.

5-Malton, K. 2006. Myths, Pitfalls arid Oversights, Renewable Energy Policy and Politics: A Handbook for Decision Making- Earth Scan.

e-Learning Source:

https://docs.google.com/document/d/1ud7CjOPqPqTj_4nvdj8uZFHsXWCPh03J/edit?usp=sharing&ouid=114555250431858417199&rtpof

https://www.youtube.com/watch?v=EM1IyIyr-Zc

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

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

4- 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: 2023-24							
Course Code	**B150506P/ES319**	**Title of the Course**	**Energy Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 Physics, Chemistry, Botany	**Co-requisite**	Nil				
Course Objectives	This course provides students with a working knowledge of utilization and importance of non-conventional energy resources						

Course Outcomes	
CO1	Students will able to calculate the efficiency of Solar photovoltaic panel (PV) by I-V curve.
CO2	Students will able to determine the power generated by Wind turbine using I-V curve w.r.t. distance of rotor generator from the source of wind
CO3	Students will learn about Biogas production by Anaerobic Digester.
CO4	Students will able about the Synthesis and determination of Biodiesel from vegetable oil by transesterification method.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Calculation of Efficiency of PV panel	To calculate the efficiency of Solar photovoltaic panel (PV) by I-V curve	15	CO1
2	Determination of Power generation	To determine the power generated by Wind turbine using I-V curve w.r.t. distance of rotor generator from the source of wind	15	CO2
3	Biogas Production	Biogas production by Anaerobic Digester	15	CO3
4	Synthesis and Determination of Biodiesel	Synthesis and Determination of Biodiesel from vegetable oil by transesterification method	15	CO4

Reference Books:

- W. Kurge: ISO 14001 Certification – Environmental Management System, Prentice Hall, 1995
- Power plant engineering, P.K. Nag, McGraw-Hill
- Rai, G.D. Non Conventional Energy Sources. Khanna Publishers, New Delhi. 1998.
- Flowler, John M., "Energy and the Environment", 2nd Edition, McGraw Hill, New York, 1984.
- Carless, Jennifer, "Renewable Energy: A Concise Guide to Green Alternative", Walker, New York, 1993.

- W. Kurge: ISO 14001 Certification – Environmental Management System, Prentice Hall, 1995
- Power plant engineering, P.K. Nag, McGraw-Hill

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	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	-

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: 2023-2024							
Course Code	**B150601T/ ES321**	**Title of the Course**	**Environmental Legislation and Impact Assessment**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	VI	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 Law, Botany, Chemistry	**Co-requisite**	Nil				
Course Objectives	The course has two major components of Environmental Science: Law and EIA. The course is designed to impart knowledge to students about the history of the constitution of India and the importance and implementation of environmental laws. It will help the students to analyze the significance and compliance of laws in the Indian set-up. This course also provides a basic understanding of the EIA process as it is used for research, planning, project or program evaluation, monitoring, and regulatory enforcement. Introduce students to the legal, economic, administrative, and technical process of preparing and/or evaluating environmental impact documents. To relate the uses of scientific research to practical situations in project planning and decision-making.						

Course Outcomes	
CO1	Define the Indian constitutional provisions concerning environmental protection, division of powers, and fundamental rights and have an in-depth knowledge of the processes associated with EIA
CO2	Classify and know the origins, needs, and sources of environmental laws, and understand how and by whom environmental laws are made and deduced.
CO3	Develop skills and the ability to describe the complex social, scientific, and humanistic purview of environmental issues about the laws of the country
CO4	Have the ability to identify the potential impacts of proposed developments and propose solutions to address these impacts in a range of contexts.
CO5	Review the EIA process and the regulatory frameworks in which EIA operates in a range of countries

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction and History of Environmental Law**	Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies. Provision of Environmental Conservation - British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, National Forest Policy 1988.	6	CO 1
2	**Directive Principles**	Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).	4	CO 2
3	**Environmental Legislation in India**	The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Water (Prevention and Control of Pollution) Cess Act 1977; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and Other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment-friendly products, Eco marks	10	CO2&CO3
4	**Role of Government Institutions, National & International Policies**	Role of Ministry of Environment, Forests & Climate Change in environmental law and policy-making; role of central and state pollution control boards in environmental law and policy-making; National Green Tribunal; National Environment Policy, 2006. Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.	8	CO2 &CO3
5	**Introduction to EIA**	Environmental impact assessment (EIA): definitions, introduction, and concepts; rationale and historical development of EIA; scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP)	6	CO 4
6	**India's Status & Rapid EIA**	EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects! thermal projects. Strategic Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO	8	CO 4

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		14000; sustainable development.		
7	**Risk assessment**	Introduction and scope; Project planning; Exposure assessment; Toxicity assessment; Hazard identification and assessment; Risk characterization; Risk communication; Environmental monitoring; Community involvement; Legal and regulatory framework; Human and ecological risk assessment. Review of different Case studies on Environmental Laws and EIA.	8	CO 5
8	**Case studies**	Relevant Case studies related to environmental conservation via laws and Environmental Impact Assessments case studies	10	CO5

Reference Books:

1. Divan S. and Rosencranz A. (2005) Environmental Law and Policy in India, 2nd ed., Oxford, New Delhi
2. Leelakrishnan P. (2008) Environmental Law in India, 3rd ed., Lexis Nexis, India
3. Armin Rosencranz - Environmental Law and Its Policy in India.
4. P. Leelakrishnan - Environmental Law in India /Cases.
5. Birnie P. (2009) et al., International Law and the Environment, 3rd ed., Oxford.
6. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill, New York, 1996.
7. Handbook of Environmental Impact Assessment Vol I and II, J. Petts, Blackwell Science, London, 1999.
8. The Theory and the Practice of Environmental Impact Assessment, S. A. Abbasi and N. Ramesh, DPH, New Delhi, 2003.
9. Complete Guide to ISO 14000, R. B. Clements. Simon & Schuster, 1996.
10. Environmental Management, Kulkarni, V. and Ramachandra T.V., Capitol Pub. Co., New Delhi. 2006
11. Handbook of Environmental Impact Assessment, Petts, J. - Volume 1 and 2. Blackwell Publishers, UK 2005.
12. Introduction to Environmental Impact Assessment, Glasson, J. Therivel, R. and Chadwick, A. Routledge, London. 2006

e-Learning Source:

MOOC

SWAYAM

EIA reports for various sectors are available on the official website of the Ministry of Environment and Forest (www.envfor.nic.in)

EIA Manuals prepared by ASCI and IL & FS on the official website of the Ministry of Environment and Forest (http://environmentclearance.nic.in/)

Standard terms of reference [TOR] for EIA / EMP report for projects/activities requiring environment clearance under EIA notification, 2006 (http://moef.gov.in/sites/default/files/final%20Booklet.pdf)

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

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

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

Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2023-2024							
Course Code	**B150603P/ ES322**	**Title of the Course**	**Practical on EIA, Biostatistics, and Computer Applications**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	VI	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 Law, Botany, Chemistry	**Co-requisite**	Nil				
Course Objectives	Upon successful of this Lab. course students should be able to know about process of EIA, calculation of Mean, Median & Mode, Graphical representation of data & Applications in Statistics and EIA Case Studies.						

Course Outcomes	
CO1	Students will be able to understand about process of EIA
CO2	Students will be able to study about calculation of Mean, Median & Mode
CO3	Students will be able to study about Graphical representation of data & Applications in Statistics
CO4	Students will be able to study about EIA Case Studies

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	EIA	To study about EIA process	15	CO1
2	Biostatistics	To Study about calculation of Mean from a given Data To Study about calculation of Median from a given Data To Study about calculation of Mode from a given Data	15	CO2
3	Computer Applications	To study about Graphical representation of data & Applications in Statistics	15	CO3
4	Application of EIA by Case Studies	To study about EIA Case Studies	15	CO4

Reference Books:

1. Introduction to Biostatistics By S Chand

2. Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities, Third edition by Barbara Carroll, Josh Fothergill, Jo Murphy and Trevor Turpin

3. Practical Statistics for Data Scientists by Peter Bruce, Andrew Bruce

e-Learning Source:

https://www.youtube.com/watch?v=5OEDrvFjCME

https://www.youtube.com/watch?v=3F_V5alJubk

https://www.youtube.com/watch?v=co9G_-L3_7U

https://www.youtube.com/watch?v=K5ikiXyqOgw

	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	2	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-

6- 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:2023-2024							
Course Code	**B150602T/ES323**	**Title of the Course**	**Environmental Priorities and Research Tools**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2, Chemistry, Biology, Geography	**Co-requisite**	Nil				
Course Objectives	This course provides students environmental movements, priorities with working knowledge of Basic Analysis methods and principles of related Instruments						

Course Outcomes	
CO1	Learn about general national environmental movements and Rivers Action Plans, Sustainable development and Human Health.
CO2	Develop understanding about different environmental disasters and their management.
CO3	Students will be able to understand about Chemical & Biological hazards.
CO4	Able to understand the environmental priorities in India. Students will learn about increase in population growth, its impact on environment and welfare programs.
CO5	Developed skills about environmental sampling& analysis Techniques.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	National Environmental movement and River Plans	Silent valley movement, Chipko movement, Narmada movement, Green Revolution, Appiko movement, Tehri Dam movement; Namami Gange and Yamuna Action Plan; International Solar Alliance.	8	CO1
2	Environmental Priorities in India**:**	Sustainable Development; Urban and Rural planning, Power generation; Human Population Explosion; Environment and human health; Sanitation and health education; Role of information technology in environment and human health	8	CO1
3	Environmental Disaster	Natural hazards; earthquake, flood, cyclones,landslides, desertification and fire; Resettlement and rehabilitation process; NDRF/SDRF; NDMA	8	CO2
4	Environmental Toxicology	Environmental Toxicants, Water borne pathogens and diseases, Pesticides and heavy metal toxicity, Bioindicators	6	CO3
5	Environmental Approaches	Population growth, variation among nations, Need for gender equity, Population explosion - Family Welfare Programme. Human Rights and Value Education. National Green Tribunal.	8	CO4
6	Environmental research methodology	Concept of secondary and primary data sources. Spatial and non-spatial data. Environmental sampling: sampling designs, sampling types, representative samples – its characteristics. Sampling errors, calibration. Concept of control, blank and standards. Concept of detection limits.	8	CO4
7	Environmental sampling & Analysis	Environmental sampling techniques - air, water, soil, noise, aquatic and soil biota. Sample handling, transportation and preservation.	6	CO5
8	Instrumentation Analysis	Introduction to Techniques, Basic principles, and applications- Centrifuge, Titration, pH meter Conductivity meter, Nephelometry; Gravimetry; Microscopy; Ultraviolet-visible (UV-VIS) Spectroscopy, Flame photometry	8	CO5

Reference Books:

1)Agarwal, K.C. 2001 Environmental; Biology, Nidi Pub. Ltd. Bikaner.

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

3) Disaster Management and Preparedness. Nidhi Dhawan and Ambrina Sardar Khan

4) Hand Book of Analytical Instruments 2006 McGraw-Hill Education Private Limited

e-Learning Source:

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

https://byjus.com/free-ias-prep/disaster-management-india/

https://byjus.com/free-ias-prep/disaster-management-india/

PO-PSO																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	1	1	3	2	-	-	-	-	-	3	2	3	1	3
CO2	2	1	3	1	1	3	2	-	-	-	-	-	3	2	3	1	3
CO3	2	1	3	1	1	3	2	-	-	-	-	-	3	2	3	1	3
CO4	2	1	3	1	1	3	2	-	-	-	-	-	3	2	3	2	3
CO5	2	1	3	1	1	2	2	-	-	-	-	-	3	2	3	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: 2023-2024							
Course Code	**B150604T/ ES324**	**Title of the Course**	**Environmental Management Strategies**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Physics, Chemistry & (Maths/ Biology)	**Co-requisite**					
Course Objectives	To Provide Knowledge of Sustainable Development. To learn about different methods of solid waste management and Hazardous waste management, conservation of soil and water. To understand the EMS and laws for Environment Management.						

Course Outcomes	
CO1	To gain Knowledge of Sustainable Development
CO2	To gain Knowledge about different methods for solid waste management and hazardous waste management
CO3	To understand different strategies for conservation of soil and water
CO4	To gain Knowledge about EMS.
CO5	To learn the laws for Management of Environment

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	General concept for Environment management	Concept of Sustainable Development, Green Technologies, Forest Management, Wildlife Management, Project Tiger, Range Management.	8	CO1
2.	Solid Waste Management	Solid Waste: Definition. Characteristic and perspectives. Sources of solid waste. Classification. Characteristic of solid waste: physical, chemical and biological. Solid waste generation. Factors affecting solid waste generation. Handling and separation of solid waste at source. Method of collection. Transfer station. Location of transfer station. Waste reduction techniques: recycling- paper and paper board, plastics and glass.	8	CO2
3.	Hazardous Waste Management	Definition. Classification. Hazardous waste generation. Nuclear waste. Biomedical waste. Chemical waste. Identification of hazardous waste. Electronic waste (E-waste). Hazardous waste treatment technology: On-site disposal: physical, chemical and biological. Off-site disposal: Co-disposal and sanitary landfilling. E-waste management. Biomedical waste management: autoclave, hydroclave, microwave, plasma treatment and disinfection by solar radiation.	12	CO2
4.	Conservation of soil and its management	Soil, Types of soil, Soil erosion, Soil conservation techniques, Land conservation strategies, Biofertilizers, Organic farming, Bioremediation, Waste land Reclamation.	8	CO3
5.	Water conservation and its management	Water resources: Types and use of water resources, Methods of enhancing fresh water supply, Watershed management and its importance, Sustainable use of water resources, Rain water harvesting.	8	CO3
6.	EMS	Environmental Management System: Origin of EMS. ISO 9001-2008. Role of EMS, purpose, core element of EMS, ISO 14001:2004, ISO 14023:2004. .	8	CO4
7.	Laws for Environment Management	Wildlife Protection Act 1972, Water Prevention and control of pollution Act 1974, Forest Conservation Act 1980, Air prevention and control of Pollution Act 1981, Environmental Protection Act 1986 Environmental Economics: Tool for pollution prevention. Public disclosure and pollution control. Polluter pay principle. Industrial rating	8	CO5

Reference Books:

1-Rau, J.G. and Wooten, D.C (1980) Environmental Impact Analysis Hand Book, Mc Graw Hill, USA.

2-Houghton,J. 2005. Global warming: The Complete Briefing. Cambridge: Cambridge University Press. Cambridge.

3-Sanjay Saxena (2003) A First course in computers, Vikas publishing house Pvt. Ltd, New Delhi

4-Odum, E. P., (1971) Fundamentals of Ecology, W. B., Saunders Company, Philadelphia

6. Environmental management: G. N. Pandey; Vikash Publishing House

7. Environmental management: H. M. Saxena; Rawat Publications

e-Learning Source:

1-https://www.youtube.com/watch?v=QJGKkRpeIUY

2-https://www.youtube.com/watch?v=Lq4suQu6FPo

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

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

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

Integral University, Lucknow
Department of Environmental Science

Effective from Session: 2023-2024							
Course Code	**B150605T/ ES325**	**Title of the Course**	**Environmental Monitoring and Modelling**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	VI	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Science	**Co-requisite**	Nil				
Course Objectives	This course aims to provide an introduction to the fundamental monitoring & modeling concepts, and their applications in simulating pollution monitoring and resource utilization in natural environmental systems. The tools and techniques help in investigating, understanding, representing the current, and predicting the future state of the environment.						

Course Outcomes	
CO1	Recall basic concepts and principles of environmental monitoring.
CO2	Summarize definitions of sample, its types etc. Explain various steps and precautions required before sampling of soil, water, air etc.
CO3	Understand the different modeling approaches, their scope and limitations
CO4	Become aware of a wide range of applications of modelling in environmental management & decision-making.
CO5	To understand the basic principle and application of instruments.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of Environmental Monitoring	What is environmental quality? Quality of environment for life on earth and man; Advantages of Environmental Monitoring, Deterioration of environmental quality concerning anthropogenic impact; Methods of assessment of environmental quality; Short-term studies/surveys; Rapid assessment; Continuous short- and long-term monitoring	8	CO1
2	Water Monitoring	Objectives of water monitoring, Collection of samples, sample preservation, Physical, chemical, and biological parameters of water & its monitoring, General effluent standards, stream standards Drinking water standard (IS10500 and WHO Standards),	8	CO2
3	Air Monitoring	Air sampling: types, techniques, Site and parameter selection, National standards for ambient air quality, monitoring of particulate matter, SOx and NOx, Ambient and stack air monitoring techniques, Air Monitoring tools/instruments used for air its work principle	6	CO2
4	Soil Monitoring	Objectives of soil monitoring/testing, Types of soil sampling and sample units, Site selection, Important soil quality indicators Instruments/equipment used in soil monitoring	6	CO2
5	Introduction	Environmental modeling: scope and problem definition, goals and objectives, definition; modeling approaches– deterministic, stochastic and the physical approach; applications of environmental models; the model building process	8	CO3
6	Concept of Environmental Modelling	Introduction to environmental system analysis; Approaches to the development of models, linear simple and multiple regression models; Validation and forecasting Modelling techniques; Model performance, accuracy and utilization	8	CO4
7	Environmental Modelling Applications	Water quality modeling: surface water quality modeling – lakes and impoundments, rivers; groundwater pollution modeling Air quality modeling: the box model, the Gaussian plume model point sources, line sources, area sources; special topics; Gaussian puff model	8	CO4&5
8	Instruments in Environmental Monitoring	pH meter, Conductivity meter, Colorimeter, UV Spectrophotometer, Atomic absorption spectrophotometer, Flame photometer, Hot air oven, autoclave, laminar flow, RSPM 2.5, Gas chromatography, Mass spectroscopy, Scanning electron microscopy	8	CO5

Reference Books:

1-Handbook of Methods in Environmental Studies: Vol.1 By Maiti, Subodh. (2003).

2-Handbook of Methods in Environmental Studies: Vol 2 (Air, noise, soil and overburden analysis). By Maiti, Subodh. (2003).

3-Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd., 1994.

4-Maity, S.K. 2014. Handbook of Methods in Environmental Studies Vol-I & II. Oxford Book Company, New Delhi

5-Gupta, P.K. 2011. Methods in Environmental Analysis: Water, Soil, Air (2nd Edition) Vatsal Enterprises, New Delhi

6-Trivedy, R.N. 2002. A Text Book of Environmental Pollution and Control. Anmol Publication, New Delhi.

7-Ramaswami A., Milford J.B. and Small M.J. (2005) Integrated Environmental Modelling, John Wiley and Sons, Inc., New Jersey.

8-Schnoor J.L. (1996) Environmental Modeling, John Wiley & Sons, Inc., New York.

e-Learning Source:

SWAYAM, MOOC, NPTEL

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	1	2	2	3	3	3	3						1	1	1	1		
CO2	3	2	3	3	3	3	2						1	2	2	2		
CO3	1	1	2	2	2	3	3						3	3	2	1		
CO4	3	3	3	3	3	3	3						1	2	2	2		
CO5	2	2	2	1	1	1	1						3	3	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: 2023-2024							
Course Code	**B150606P/ ES326**	**Title of the Course**	**Environmental monitoring Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	VI	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Science	**Co-requisite**					
Course Objectives	The course is designed to develop sampling and analytical skills of the students which are required in environmental monitoring. The students will be exposed to various standard protocols used in environmental monitoring.						

Course Outcomes	
CO1	Students will be trained in analytical and conceptual skills required for soil analysis.
CO2	Students will be trained in analytical and conceptual skills required for water analysis.
CO3	Students will be trained in analytical and conceptual skills required for air monitoring.
CO4	Students will be expert in instrumental experiment of environmental monitoring.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Soil monitoring**	Analysis of soil moisture content by oven dry method. Determination of electrical conductivity of soil sample.	15	CO1
2	**Water monitoring**	Determination of total alkalinity of water sample. Determination of chloride content of water sample.	15	CO2
3	**Air monitoring**	Determination of physical composition and characteristics of municipal solid waste. Analysis of nitrogen dioxide (NO2) and suspended particulate matter (SPM) in air	15	CO3
4	**Environmental Monitoring Instrument**	pH meter, Conductivity meter, Colorimeter, UV Spectrophotometer, Atomic absorption spectrophotometer, Flame photometer, Hot air oven, autoclave, laminar flow, RSPM 2.5, Gas chromatography, Mass spectroscopy, Scanning electron microscopy	15	CO4

Reference Books:

Radojevic M. and Valdimir N.B. (2006) Practical Environmental Analysis, RSC publishing

APHA (1980) Standard Methods for the Examination of Water and Wastewater Published by American Public Health Association, 15th ed.

Wagner T.P. and Robert S. (2009) Environmental Science: Active Learning Laboratories and Applied Problem Sets, 2nd Edition, Wiley.

Wells E. (2009) Lab Manual for Environmental Science, Cengage Learning

e-Learning Source:

SWAYAM

MOOC

NPTEL

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

Effective from Session:2023-2024							
Course Code	**B150607R/ ES327**	**Title of the Course**	**Internship/Apprenticeship, (Research Project III)**	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	VI	**0**	**0**	**0**	**3**
Pre-Requisite	10+2 Botany, Physics, Chemistry	**Co-requisite**	Nil				
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.						

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	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,

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	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			

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

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