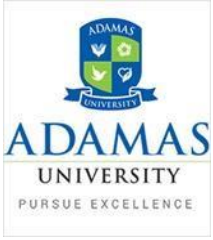

Adamas University
School of Basic and Applied Sciences
Department of Chemistry

Programme Structure and Syllabus of B.Sc. (NEP)
Environmental Science

Programme Code: CHM3406
Duration: 4 Years Full Time
Academic Year 2024-25

Vision of the University

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

Mission of the University

- Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology
- Foster outcomes based education system for continuous improvement in education, research and all allied activities
- Instill the notion of lifelong learning through culture of research and innovation
- Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date
- Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

Core Values

- Respect
- Positivity
- Commitment
- Accountability
- Innovation

Vision of the School

To become a globally recognized centre of higher learning in applied sciences with an innovative approach to disseminating knowledge, research, innovation, and excellence in order to address society's challenges.

Mission of the School

- To provide comprehensive knowledge in applied sciences through problem solving and analytical approach using innovative pedagogy.
- To promote global excellence in teaching and learning, interdisciplinary research, innovation and entrepreneurship to provide sustainable solutions for the upcoming challenges of the society.
- To facilitate and promote industry-academia collaboration in order to improve skills and employability.
- To instill core values, ethics, lifelong learning, professional and social responsibilities towards solving global interdisciplinary problems.
- Inculcate ethical principles and develop understanding of environmental and social realities

Vision of the Department

To become a globally recognized centre of higher learning in applied sciences with an innovative approach to disseminating knowledge, research, innovation, and excellence in order to address society's challenges.

Mission of the Department

- To provide comprehensive knowledge in applied sciences through problem solving and analytical approach using innovative pedagogy.
- To promote global excellence in teaching and learning, interdisciplinary research, innovation and entrepreneurship to provide sustainable solutions for the upcoming challenges of the society.
- To facilitate and promote industry-academia collaboration in order to improve skills and employability.
- To instill core values, ethics, lifelong learning, professional and social responsibilities towards solving global interdisciplinary problems.
- To instill core values, ethics, lifelong learning, professional and social responsibilities towards solving global interdisciplinary problems.

Programme Educational Objectives (PEO) of BSc (NEP) Environmental Science

PEO1 The graduates will establish themselves as successful global professionals by solving real-life problems using scientific knowledge and analytical skills gained in the field of Applied Sciences.

PEO2 The graduates will provide cost-effective eco-friendly sustainable solutions for the societal problem through the interdisciplinary research, innovation and entrepreneurship.

PEO3 The graduates will become employable with required skills for different sectors as a result of industry-academia collaboration.

PEO4 The graduates will practice moral values, professional ethics and social responsibilities while performing their duties to provide solutions to global problems.

Programme Outcomes (POs) of BSc (NEP) Environmental Science

PO1	**Critical Thinking**	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication**	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	**Social Interaction**	Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship**	Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics**	Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability**:	Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Life-long Learning**	Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.
PSO1		Understand the nature and concept of Data Science and develop the skill to think critically on abstract concepts of Data Science.
PSO2		Create, select, and apply appropriate techniques, resources, and modern data science specific tools to solve real-life problem in various fields.
PSO3		Develop data centric predictive and decision making expert system using AI & ML.

Program Outcome Vs Courses Mapping Table of Semester: I

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS101	Ecology and Ecosystems	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	1	1	2	1	3	3	2	1	1
		CO	2.7	1.5	1.8	2.3	2.0	1.8	2.0	1.8	1.7	1.7
EVS102	Energy and Environment	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	1	1	2	1	2	3	2	2	2
		CO	2.0	1.5	1.5	2.6	2.0	1.7	2.2	1.6	1.8	1.8

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences
Department of Chemistry
BSc (NEP) Environmental Science
Batch: 2024-2025
Semester: I

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS101	Ecology and Ecosystems	2	1	1	4	4
2.	CC	EVS102	Energy and Environment	2	1	1	4	4
3.	MDC		MDC-I (To be chosen from bucket provided)	3	0	0	3	3
4.	AEC	AEC101	Communicative English-I	3	0	0	3	3
5.	Minor		Minor I (To be chosen from bucket provided)	3	1	0	4	4
6.	VAC		Environmental Education-I	2	0	0	2	2
	TOTAL						**20**	**20**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Ecology and Ecosystems

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**I**
Course Title	**Ecology and Ecosystems**
Course Code	**EVS101**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Comprehend the fundamental principles and definitions of ecosystem ecology, including ecosystem stability, resistance, resilience, and the biogeographic zones in India. • Analyze the concepts of ecological niches, ecological amplitude, phenotypic plasticity, and strategies of adaptation in plants and animals. • Understand population ecology, including population density, dispersion, growth models, and the dynamics and regulation of populations. • Evaluate community ecology, including community structure, species diversity, ecological succession, and the stability and diversity of ecosystems. • Examine behavioral ecology, including learning, imprinting, sexual selection, sociobiology, and kin and group selection.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Describe and explain the key concepts and definitions related to ecosystem ecology, including ecosystem stability,

	types of ecosystems, and nutrient cycles. **CO2:** Identify and explain the ecological niche, ecological amplitude, phenotypic plasticity, and strategies of adaptation in different organisms. **CO3:** Analyze population ecology concepts such as population density, dispersion, growth models, and dynamics, and apply this knowledge to real-world scenarios. **CO4:** Evaluate community ecology principles, including community structure, species diversity, ecological succession, and ecosystem stability. **CO5:** Demonstrate an understanding of behavioral ecology, including learning, imprinting, sexual selection, and sociobiology, and apply these concepts to the study of ecological interactions. **CO6:** Assess the impact of anthropogenic activities on ecosystems and biodiversity, and propose sustainable strategies for conservation and management of natural resources.

Course Outline

Module	Description
I	**Ecosystem Ecology** Basic concepts and definitions: biosphere, ecology, landscape, ecosystems, ecosystem stability, resistance and resilience; concepts of autecology and synecology; Biogeographic zones in India and concepts of Protected Area Network; Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; Aquatic ecology Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy; Carbon cycle; nitrogen cycle; phosphorus cycle;

	sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.
II	**Ecology of individuals** Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals
III	**Ecology of populations** Concept of population and meta-population; characteristics of population density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; population fluctuations; population interaction and regulations; r- and K-selection; limits to population growth; deterministic and stochastic models of population dynamics; Population dispersion, fluctuations, interaction, distribution, regulations; ruderal, competitive and stress-tolerance strategies,
IV	**Community Ecology and Ecological succession** Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; Concepts of species diversity; Concepts of stability and diversity in ecosystem; ecological succession: primary and secondary successions, concepts of allogenic and autogenic succession, models and types of successions, Facilitation, Tolerance and Inhibition; Concept of sere, climax community concepts, examples of succession (aquatic and terrestrial)
V	**Behavioral Ecology** Learning and Imptinting, types of examples; Sexual Selection, Red Queen Hypothesis, Handicap Principle; Basic concepts of sociobiology; Basis of kin and group selection; Reciprocal Altruism

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Groom. B. & Jenkins. M. 2000.*Global Biodiversity: Earth's Living Resources in the 21st Century*. World Conservation Press, Cambridge, UK.

2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. *The Ecology of Plants*. Sinauer associates incorporated.
3. Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem functioning: Synthesis and Perspectives.* Oxford University Press, Oxford, UK.
4. Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Sounders.
5. Pandit, M.K., White, S.M.& Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. *New Phytologist*. 203: 697-703.
6. Pimentel, D. (Ed.). 2011. *Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species*. CRC Press.
7. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. *Ecology, Environment and Resource Conservation.* Anamaya Publications.
8. Wilson, E. O. 1985. The Biological Diversity Crisis. *BioScience* 35: 700-706.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Energy and Environment

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**I**
Course Title	**Energy and Environment**
Course Code	**EVS102**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the fundamental concepts of energy, its various forms, and its historical significance in human development. • Explore global energy resources, both renewable and non-renewable, their distribution, availability, and technologies for their utilization. • Analyze global energy demand, examining historical trends, sector-specific uses, and changes in demand across different economies. • Evaluate the environmental and societal impacts of energy production and consumption, including issues related to fossil fuels, nuclear energy, and social inequalities. • Examine the political landscape of energy policy, with a focus on global and Indian contexts, and explore future energy use patterns and sustainability strategies.
Course Outcome (CO)	**After completion of this course, students will be able to:**

	CO1: Define energy and describe its forms and historical importance, including key milestones such as the discovery of fire and nuclear energy. **CO2:** Identify and explain global energy resources, both renewable and non-renewable, and the technologies used for their integration into energy infrastructure. **CO3:** Analyse and interpret global energy demand data, including sector-specific uses and changes in demand in different economies. **CO4:** Evaluate the environmental and societal impacts of energy use, including issues related to air pollution, global warming, radioactive waste, and social inequalities. **CO5:** Understand the political aspects of energy policy, both globally and in India, and develop strategies for sustainable energy use in the future. **CO6:** Demonstrate knowledge of emerging energy technologies, such as smart grids, energy storage systems, and hydrogen fuel, and assess their potential to transform global energy systems toward sustainability.

Course Outline

Module	Description
I	**Introduction** Defining energy; forms and importance; energy use from a historical perspective: discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, oil wars in the Middle East, advent of nuclear energy; sources and sinks of energy; energy over-consumption in urban setting.
II	**Energy resources** Global energy resources; renewable and non-renewable resources, specific examples: distribution and availability; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation.

III	**Energy demand** Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban environments; changes in demand in major world economies; energy subsidies and environmental costs.
IV	**Energy, environment, and society** Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use.
V	**Energy and the environment** 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 impact on the environment, economy, and global change.
VI	**Politics of energy policy** Political choices in energy policy globally and in the Indian context (historical and contemporary case studies); domestic and international energy policy; energy diplomacy and bilateral ties of India with her neighbours.
VII	**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 (biofuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy mix and management from a future perspective.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. McKibben, B. 2012. *Global Warming's Terrifying New Math*, Rolling Stone Magazine.
2. Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. *Resources of the Earth: Origin, use, and environmental impact* (2nd edition). Prentice Hall, New Jersey.
3. Elliott, D. 1997. *Sustainable Technology. Energy, Society and Environment* (Chapter 3). New York, Routledge Press.

4. Rowlands, I.H. 2009. *Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies* in Debora L. Van Nijnatten and Robert Boardman (eds), Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. 167-82.
5. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July.
6. Mallon, K. 2006. *Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making*. EarthScan.

Program Outcome Vs Courses Mapping Table of Semester: II

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS103	Physics and Chemistry of the Environment	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	2	3	3	1	3	3	1	3	2
		CO	**2.7**	**1.7**	**2.2**	**2.5**	**2.0**	**1.8**	**2.0**	**1.7**	**2.0**	**1.8**
EVS104	Atmospheric science and Climate Change	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	3	3	3	3	2	1	1	3	2	2
		CO	**2.3**	**1.8**	**1.8**	**2.8**	**2.2**	**1.5**	**1.8**	**1.8**	**1.8**	**1.8**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: II

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS103	Physics and Chemistry of the Environment	2	1	1	4	4
2.	CC	EVS104	Atmospheric science and Climate Change	2	1	1	4	4
3.	MDC		MDC-II (To be chosen from bucket provided)	3	0	0	3	3
4.	SEC		SEC I (To be chosen from bucket provided)	1	0	1	2	2
5.	VAC		To be chosen from bucket provided	2	0	0	2	2
6.	AEC	AEC102	Communicative English-II	3	0	0	3	3
7.	Minor		Minor II (To be chosen from bucket provided)	3	0	1	4	4
	TOTAL						**22**	**22**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Physics and Chemistry of the Environment

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**II**
Course Title	**Physics and Chemistry of the Environment**
Course Code	**EVS103**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the fundamental concepts of environmental physics, including pressure, force, work, energy, heat transfer, and thermodynamics. • Explore the basics of environmental chemistry, including atomic structure, chemical bonds, thermodynamics, and organic chemistry. • Analyze the composition and chemical reactions of the atmosphere, focusing on photochemical reactions, smog formation, and ozone layer depletion. • Investigate the chemical and physical properties of water, including its acidity, hardness, and the behavior of metals and colloids in water. • Examine soil chemistry, including the composition of soil, cation and anion exchange reactions, and the presence of nutrients and organic matter in soil.
Course Outcome (CO)	**After completion of this course, students will be able to:**

	CO1: Understand the fundamental concepts of environmental physics, including pressure, force, work, energy, heat transfer, and thermodynamics, and their applications in environmental systems. **CO2:** Explore the basics of environmental chemistry, including atomic structure, chemical bonds, thermodynamics, and organic chemistry, with a focus on environmental relevance. **CO3:** Analyze the composition and chemical reactions of the atmosphere, focusing on photochemical reactions, smog formation, ozone layer depletion, and their environmental impacts. **CO4:** Investigate the chemical and physical properties of water, including its acidity, hardness, and the behavior of metals and colloids in aquatic systems, and apply this knowledge to water quality assessment. **CO5:** Examine soil chemistry, including the composition of soil, cation and anion exchange reactions, and the presence of nutrients and organic matter, with a focus on soil health and fertility. **CO6:** Evaluate the interplay between environmental physics and chemistry in pollution control strategies, climate change mitigation, and sustainable resource management.

Course Outline

Module	Description
I	**Fundamentals of Environmental Physics** Basic concepts of pressure, force, work and energy; types of forces and their relation (pressure gradient, viscous, Coriolis, gravitational, centripetal, and centrifugal force); concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind-mills and hydroelectric power plants. Basic concepts of light and matter; spectroscopic concepts: Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic and solar cells; scattering of light, Rayleigh and Mie's scattering.
II	**Fundamentals of environmental chemistry** Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis.

	Thermodynamics and chemical equilibrium; types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells. Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, basic concepts of organic synthesis.
III	**Atmospheric chemistry** Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO_2 and SO_2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.
IV	**Water chemistry** Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals and metalloids in water.
V	**Soil chemistry** Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.
VI	**Movement of pollutants in environment** Diffusion and dispersion, point, line and area source pollutants, pollutant dispersal; Gaussian plume model, Inversion and mixing heights, hydraulic potential, Darcy's equation, types of flow, laminar and turbulence, super-critical, critical and sub-critical.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Beard, J.M. 2013. *Environmental Chemistry in Society* (2nd edition). CRC Press.
2. Boeker, E. & Grondelle, R. 2011. *Environmental Physics: Sustainable Energy and Climate Change*. Wiley.
3. Connell, D.W. 2005. *Basic Concepts of Environmental Chemistry* (2nd edition). CRC Press.
4. Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.
5. Girard, J. 2013. *Principles of Environmental Chemistry* (3rd edition). Jones & Bartlett.
6. Harnung, S.E. & Johnson, M.S. 2012. *Chemistry and the Environment*. Cambridge University Press.

7. Hites, R.A. 2012. *Elements of Environmental Chemistry* (2nd edition). Wiley & Sons.
8. Manahan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
9. Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Atmospheric science and Climate Change

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**II**
Course Title	**Atmospheric science and Climate Change**
Course Code	**EVS104**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the basic concepts of weather and climate, the evolution and development of Earth's atmosphere, and the significance of the atmosphere in sustaining life. • Analyze Earth's global energy balance, including energy transfers in the atmosphere, the radiation budget, and the role of greenhouse gases. • Explore atmospheric circulation patterns, including air mass movement, air-sea interactions, and phenomena such as El Niño, La Niña, and the Indian monsoon. • Examine meteorological parameters and atmospheric

	stability, including temperature inversion and plume behavior. • Evaluate the trends and drivers of global warming and climate change, and their impacts on weather patterns, sea levels, agriculture, and biological responses. • Understand the causes and effects of ozone layer depletion, including the Chapman cycle, and examine mitigation measures and international protocols.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Describe the fundamental concepts of weather and climate, and explain the evolution, structure, and significance of Earth's atmosphere. **CO2**: Analyze Earth's energy balance and the role of greenhouse gases in the greenhouse effect and climate regulation. **CO3**: Explain atmospheric circulation patterns, air-sea interactions, and the impact of phenomena such as El Niño, La Niña, and the Indian monsoon on climate. **CO4**: Evaluate meteorological parameters and understand atmospheric stability, temperature inversion, and plume behavior using the Gaussian plume model. **CO5**: Assess the trends and drivers of global warming and climate change, and their effects on the atmosphere, weather patterns, sea levels, agriculture, and ecosystems. **CO6**: Understand the processes and causes of ozone layer depletion, and evaluate the effectiveness of mitigation measures and international protocols.

Course Outline

Module	Description
I	**Introduction** Concepts of weather and climate; Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles, greenhouse effect and its effect on environment.
II	**Global energy balance** Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; greenhouse gases (GHGs); greenhouse effect; global conveyor belt.
III	**Atmospheric circulation** Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian

	monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on microclimate; Asian brown clouds.
IV	**Meteorology and atmospheric stability** Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model.
V	**Global warming and climate change** Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO_2 fertilization and agriculture; impact on economy and spread of human diseases.
VI	**Ozone layer depletion** Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of springtime ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK.
2. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
4. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
5. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications.

Program Outcome Vs Courses Mapping Table of Semester: III

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS201	Water And Water Resources Management	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	3	1	2	2	2	3	2	1
		CO	**2.3**	**1.7**	**2.2**	**2.2**	**2.2**	**1.7**	**1.8**	**2.0**	**1.8**	**1.7**
EVS202	Land and Soil Conservation and Management	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	3	2	2	2	3	2	3	1	1
		CO	**2.2**	**1.8**	**1.7**	**2.6**	**2.2**	**1.8**	**2.0**	**1.8**	**1.6**	**1.6**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: III

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS201	Water And Water Resources Management	2	1	1	4	4
2.	CC	EVS202	Land and Soil Conservation and Management	2	1	1	4	4
3.	MDC			3	0	0	3	3
4.	Minor		Minor III (To be chosen from bucket provided)	2	1	1	4	4
5.	AEC			2	0	0	2	2
6.	SEC		SEC II (To be chosen from bucket provided)	2	0	0	2	2
7.	VAC			2	0	0	2	2
	TOTAL						**21**	**21**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Water And Water Resources Management

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**III**
Course Title	**Water And Water Resources Management**
Course Code	**EVS201**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the fundamental concepts related to water sources, the hydrological cycle, and global water resources. • Explore the physical and chemical properties of water, including parameters like temperature, colour, dissolved solids, and various chemical constituents. • Analyze the characteristics and pollution issues related to surface and subsurface water, as well as methods for rainwater harvesting, artificial recharge, and watershed management. • Investigate the types, ecological significance, and conservation methods of wetlands, along with understanding international conventions related to wetland management. • Examine marine resources, their commercial use, threats to marine ecosystems, and approaches to managing marine resources and coastal zones.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Describe the sources and types of water, the hydrological cycle, and the classification of water resources, and understand the global water crisis.

	CO2: Identify and explain the physical and chemical properties of water, including key parameters like temperature, pH, dissolved solids, and chemical constituents. **CO3**: Analyze surface and subsurface water characteristics, pollution issues, and methods for rainwater harvesting, artificial recharge, and watershed management. **CO4**: Explain the types and ecological significance of wetlands, threats to wetlands, and the conservation and management methods, including international conventions like the Ramsar Convention. **CO5**: Evaluate marine resources, their commercial use, threats to marine ecosystems, and approaches to managing marine resources and coastal zones. **CO6:** Assess the impact of climate change on global water resources, including changes in precipitation patterns, glacier melting, sea level rise, and their implications for water management and ecosystem sustainability.

Course Outline

Module	Description
I	**Introduction** Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapotranspiration; classification of water resources (oceans, rivers, lakes and wetlands).' Global water crisis.
II	**Properties of water** Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio
III	**Surface and subsurface water** Introduction to surface and ground water; surface and ground water pollution; water table and piezometric surface; vertical distribution of water; classification of sub-surface lithology and types of aquifers; river structure and patterns; rainwater harvesting and artificial recharge; watershed management; classification of watershed; importance of watershed
IV	**Wetlands and their management** Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.
V	**Marine resource management** Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones); Saline water intrusion and its management
VI	**Water resource in India**

	Water resources of India, Demand for water (agriculture, industrial, domestic); water crisis; overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management.
VII	**Water resources conflicts** Water resources and sharing problems, case studies on Kaveri and Krishna river water disputes; Multipurpose river valley projects in India and their environmental and social impacts; case studies of dams - Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts.
VIII	**Major laws and treaties** National water policy; The Easement Act, 1882, Water pollution (control and prevention) Act 1974; Indus water treaty; West Bengal Ground Water Resources (Management, Control and Regulation) Act, 2005, Ganges water treaty; Teesta water treaty; Indian River linking project: ecological and economic impacts.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
3. CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science* 339: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. *Water Resource Systems Planning and Analysis*. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
7. Schward& Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
8. Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.
9. Vickers, A. 2001. *Handbook of Water Use and Conservation*. Water Plow Press.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Land and Soil Conservation and Management

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**III**
Course Title	**Land and Soil Conservation and Management**
Course Code	**EVS202**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the importance of soil health and the ecological and economic significance of soil as a resource, as well as the causes and impacts of soil degradation. • Explore the fundamentals of soil science, including soil formation, classification, physical properties, and nutrient cycles. • Analyze the causes of soil degradation, including erosion, nutrient depletion, pollution, and the effects of industrial and urban development. • Examine land use and land cover changes, the drivers of land degradation, and their impacts on biodiversity and ecosystem services. • Evaluate the costs of land degradation, its effects on farming communities and food security, and strategies for

	soil conservation and sustainable land use management.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Describe the importance of soil health, types and causes of soil degradation, and the need for soil conservation and restoration of soil fertility. **CO2**: Identify and explain the fundamentals of soil science, including soil formation, classification, physical properties, and nutrient cycles. **CO3**: Analyze the causes of soil degradation, including soil erosion, nutrient depletion, pollution, and the impact of industrial and urban development. **CO4**: Explain land use and land cover changes, drivers of land degradation, and their impacts on biodiversity, ecosystem services, and food security. **CO5**: Evaluate the costs of land degradation, including economic valuation, effects on farming communities, nutrient cycles, and future threats, and propose strategies for soil conservation and sustainable land use management. **CO6:** Demonstrate an understanding of soil remediation techniques, including bioremediation, phytoremediation, and soil amendment methods, to restore soil health and combat land degradation.

Course Outline

Module	Description
I	**Introduction** Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.
II	**Fundamentals of soil science** Soil formation; soil components; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil forming factors, soil development; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps.
III	**Soil degradation - causes** Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.
IV	**Landuse/Land cover changes and land degradation** Land resources: types and evaluation; biological and physical phenomena in land

	degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.
V	**Costs of land degradation** Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.
VI	**Soil conservation and Management of land degradation** Soil conservation; Sustainable land use planning; role of databases and data analysis in landuse planning control and management; land tenure and land policy; legal, institutional, and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation, land reclamation.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Brady, N.C. & Well, R.R. 2007.*The Nature and Properties of Soils* (13th edition), Pearson Education Inc.
2. Gadgil, M. 1993. Biodiversity and India's degraded lands. *Ambio* 22: 167-172.
3. Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman& Littlefield Publishers.
4. Marsh, W. M. & Dozier,J. 1983. *Landscape Planning: Environmental Applications*. John Wiley and Sons.
5. Oldeman, L. R. 1994. The global extent of soil degradation. *Soil resilience and sustainable land use, 9*. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
6. Pandit, M.K. et. al. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. *Biodiversity Conservation* 16: 153-163.
7. Pandit, M.K. &Kumar, V. 2013. Land use and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics.* pp. 123-133. Wiley-Blackwell, Oxford, UK .
8. Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17: 358-366.

9. Scherr, S. J. 1999. *Soil degradation: A threat to developing-country food security by 2020?* (Vol. 27). International Food Policy Research Institute.

Program Outcome Vs Courses Mapping Table of Semester: IV

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS203	Environmental Pollution and Human health	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	3	3	3	3	1	3	1	1	1
		CO	**2.7**	**1.8**	**2.2**	**2.5**	**2.3**	**1.5**	**2.0**	**1.7**	**1.7**	**1.7**
EVS204	Earth and Earth Surface Processes	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	1	3	1	2	3	2	2	2	1
		CO	**2.2**	**1.5**	**1.8**	**2.4**	**2.2**	**1.8**	**2.0**	**1.6**	**1.8**	**1.6**
EVS205	Natural Resource Management and Sustainability	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	3	3	2	3	3	1	1	3	1
		CO	**2.7**	**1.8**	**2.2**	**2.3**	**2.3**	**1.8**	**1.7**	**1.7**	**2.0**	**1.7**
EVS206	Systematics and Biodiversity	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1

		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	3	1	3	1	2	3	2	1
		CO	**2.3**	**1.7**	**2.2**	**2.2**	**2.3**	**1.5**	**1.8**	**2.0**	**1.8**	**1.7**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: IV

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS203	Environmental Pollution and Human health	2	1	1	4	4
2.	CC	EVS204	Earth and Earth Surface Processes	2	1	1	4	4
3.	CC	EVS205	Natural Resource Management and Sustainability	2	1	1	4	4
4.	CC	EVS206	Systematics and Biodiversity	2	1	1	4	4
5.	SEC		SEC III (To be chosen from bucket provided)	2	0	0	2	2
6.	Minor		Minor IV (To be chosen from bucket provided)	2	1	1	4	4
7.	VAC			2	0	0	2	2
	TOTAL						**24**	**24**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Environmental Pollution and Human health

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**IV**
Course Title	**Environmental Pollution and Human health**
Course Code	**EVS203**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the various types and classifications of environmental pollutants and their sources. • Explore the impacts of air, water, soil, noise, radioactive, thermal, and marine pollution on human health and ecosystems. • Analyse the chemical properties and behaviour of environmental pollutants, including solubility, biotransformation, and bioaccumulation. • Evaluate pollution control measures, treatment methods for wastewater and drinking water, and regulatory frameworks for pollution monitoring and control. • Conduct practical assessments of environmental pollution, including field visits, monitoring, and laboratory analysis of air, water, and soil quality.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Identify and classify different types of pollutants and their sources and understand the basic concepts of environmental pollution.

	CO2: Describe the effects of air, water, soil, noise, radioactive, thermal, and marine pollution on human health and ecosystems, and understand relevant pollution control strategies. **CO3**: Analyse the chemical properties of environmental pollutants, including solubility, transfer mechanisms, biotransformation, bioaccumulation, and radioactivity. **CO4**: Evaluate and apply various pollution control measures, wastewater treatment methods, and drinking water treatment processes, and understand regulatory frameworks for pollution control. **CO5**: Conduct practical assessments of environmental pollution through laboratory analysis of air and water quality parameters, noise monitoring, and field visits to effluent and sewage treatment plants. **CO6:** Investigate emerging pollutants such as microplastics, pharmaceuticals, and heavy metals, their impact on the environment and human health, and explore innovative technologies for their detection and mitigation.

Course Outline

Module	Description
I	**Introduction** Definition of pollution; pollutants; classification of pollutants.
II	**Air pollution** Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO_x, SO_x, PM, CO, CO_2, hydrocarbons and VOCs); indoor air pollution: sources and effects on human health.
III	**Water pollution** Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).
IV	**Soil pollution** Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies, Effects of pesticides on human health.
V	**Noise pollution** Noise pollution – sources; frequency, intensity; sound pressure level; sound intensity level and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.
VI	**Radioactive and thermal pollution**

	Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution and its effects.
VII	**Marine pollution** Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise; coastal area management; existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones).
VIII	**Chemistry of environmental pollutants** Solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage.
IX	**Pollution control** Wastewater treatment- Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG in NCT of Delhi. Methods for treatment of drinking water - aeration, flocculation, sedimentation, filtration, and disinfection. Air pollution control measures for PM (gravitational settling chambers, centrifugal collector, wet scrubber, bag house filter and ESP); for gaseous pollutant (absorption, adsorption, condensation and combustion)

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Gurjar, B. R., Molina, L. T. & Ojha C. S. P. 2010. Air Pollution: Health and Environmental
Impacts. CRC Press, Taylor & Francis.
2. Hester, R. E. & Harrison, R. M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsidas
Bhanot Publishers.
4. Pepper, I. L., Gerba, C.P. & Brusseau, M. L. 2006. Environmental and Pollution Science.

Elsevier Academic Press.
5. Purohit, S. S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
37
6. Vesilind, P. J., Peirce, J. J., & Weiner R. F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Earth and Earth Surface Processes

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**IV**
Course Title	**Earth and Earth Surface Processes**
Course Code	**EVS204**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the formation, structure, and composition of Earth, including its core, mantle, crust, lithosphere, atmosphere, and hydrosphere. • Explore the processes shaping the Earth's surface, such as continental drift, plate tectonics, earthquakes, and volcanic activities. • Learn about minerals, rocks, and the rock cycle, including the processes of weathering and erosion. • Study the Earth's atmosphere, interfaces, and surface processes, including fluvial, glacial, and coastal processes. • Analyze the importance of mountains in environmental processes, focusing on the Indian subcontinent.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Describe the formation and composition of Earth, including the geological time scale and major surface changes. **CO2**: Explain Earth system processes such as continental drift, plate tectonics, earthquakes, and volcanic activities, and their role in shaping the Earth's surface. **CO3**: Identify and classify minerals and rocks, understand the rock cycle, and explain the processes of weathering and erosion.

	CO4: Analyze the evolution and composition of Earth's atmosphere and the interactions at various interfaces, along with the impact of fluvial, glacial, and coastal processes on geomorphology. **CO5**: Evaluate the environmental significance of mountain systems, particularly in the Indian subcontinent, including their influence on climate, river systems, and human civilizations. **CO6:** Examine the importance of Earth's natural resources, including fossil fuels, minerals, and groundwater, their sustainable utilization, and the impact of overexploitation on geological and environmental systems.

Course Outline

Module	Description
I	**History of Earth** Introduction of Solar system, formation of the Earth: formation and composition of core, mantle, crust, lithosphere, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface.
II	**Earth system processes** Continental drift, Pangaea and present-day continents, evidences of continental drift; Ocean floor and sea floor spreading; Plate tectonics, major plates and hot spots, plate boundaries, mantle convection and movement of lithosphere plates; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental collision and mountain formation with specific example of the Himalaya.
III	**Minerals and rocks** Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary, and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.
IV	**Earth surface processes** Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.
V	**Importance of mountains in Environmental processes** Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent; withdrawing monsoon and lessons to draw.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Bridge, J., & Demicco, R. 2008. *Earth Surface Processes, Landforms and Sediment deposits*. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). 1993. *Holmes' Principles of Physical Geology*. Taylor & Francis.
3. Gupta, A. K., Anderson, D. M., & Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. *Nature* 421: 354-357.
4. Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. *Current Science* 90: 1082-1090.
5. Keller, E.A. 2011. *Introduction to Environmental Geology* (5th edition). Pearson Prentice Hall.
6. Krishnan, M. S. 1982. *Geology of India and Burma*. CBS Publishers & Distributors.
7. Leeder, M., Arlucea, M.P. 2005. *Physical Processes in Earth and Environmental Sciences.* Blackwell Publishing.
8. Pelletier, J. D. 2008. *Quantitative Modeling of Earth Surface Processes* (Vol. 304). Cambridge: Cambridge University Press. Chicago.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Natural Resource Management and Sustainability

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**IV**
Course Title	**Natural Resource Management and Sustainability**
Course Code	**EVS205**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the classification, availability, and conservation of natural resources, including the impact of human activities on these resources. • Learn the importance of forest, water, soil, and food resources, along with conservation strategies. • Explore the processes, types, and environmental impacts of mineral extraction and use. • Analyze the various renewable and non-renewable energy resources, their technologies, and their environmental and economic impacts. • Develop an integrated and sustainable approach to resource management, emphasizing ecological, economic, and ethnological perspectives.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Identify and classify natural resources, understand their availability, conservation, and the human impact on them. **CO2**: Explain the ecological and economic importance of forest, water, soil, and food resources, and discuss strategies for their sustainable management. **CO3**: Describe the types and processes of mineral resource extraction and evaluate the environmental effects of these

	activities. **CO4**: Assess the various renewable and non-renewable energy resources, their technologies, and their impact on the environment and global economy. **CO5**: Apply integrated resource management strategies and principles of sustainability to real-world scenarios, focusing on sustainable development and energy conservation. **CO6:** Analyze the impact of climate change and global environmental challenges on natural resource availability and propose adaptive management strategies for mitigating these impacts.

Course Outline

Module	Description
I	**Introduction** Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation; resource conservation; resource availability and factors influencing its availability; land resources; water resources; fisheries and other marine resources; energy resources; mineral resources; human impact on natural resources; ecological, social and economic dimension of resource management.
II	**Natural resources and conservation** Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation; soil resources: importance of soil, soil conservation strategies; food resources: world food problem, techniques to increase world food production, green revolution.
III	**Mineral resources** Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; global consumption patterns of mineral resources techniques to increase mineral resource supplies; ocean mining for mineral resources; environmental effects of extracting and using mineral resources.
IV	**Energy resources** Non-renewable energy resources: Oil: formation, exploration, extraction and processing, oil shale, tar sands; natural gas: exploration, liquefied petroleum gas, liquefied natural gas; coal: reserves, classification, formation, extraction, processing, coal gasification; environmental impacts of non-renewable energy consumption; impact of energy consumption on global economy; application of green technology; future energy options and challenges. Renewable energy resources: Energy efficiency; life cycle cost; cogeneration; solar energy: technology, advantages, passive and active solar heating system, solar thermal systems, solar cells, JNN solar mission; hydropower: technology, potential, operational costs, benefits of hydropower development; nuclear power: nuclear

	fission, fusion, reactors, pros and cons of nuclear power, storage of radioactive waste, radioactive contamination; tidal energy; wave energy; ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.
V	**Resource management** Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents; sustainability of society, resources, and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. *Resources of the Earth: Origin, Use, and Environmental Impacts* (2nd edition). Prentice Hall, New Jersey.
2. Freeman, A.M. 2001. *Measures of value and Resources: Resources for the Future*. Washington DC.
3. Freeman, A.M. 2003. *Millennium Ecosystem Assessment: Conceptual Framework*. Island Press.
4. Ginley, D.S. & Cahen, D. 2011. *Fundamentals of Materials for Energy and Environmental Sustainability*. Cambridge University Press.
5. Klee, G.A. 1991. *Conservation of Natural Resources*. Prentice Hall Publication.
6. Miller, T.G. 2012. *Environmental Science*. Wadsworth Publishing Co.
7. Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. *Natural Resource Conservation – Management for Sustainable Future* (7th edition). Prentice Hall.
8. Ramade, F. 1984. *Ecology of Natural Resources*. John Wiley & Sons Ltd.
9. Tiwari, G.N. & Ghosal. M. K. 2005. *Renewable Energy Resources: Basic Principles and Application*. Narosa Publishing House.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Systematics and Biodiversity

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**IV**
Course Title	**Systematics and Biodiversity**
Course Code	**EVS206**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the principles of taxonomic hierarchy, nomenclature, and the classification of life forms. • Explore the evolutionary and ecological significance of biodiversity at genetic, species, and ecosystem levels. • Recognize the economic, ecological, and social importance of biodiversity and ecosystem services. • Analyze the impact of natural and anthropogenic factors on biodiversity and the strategies for its conservation. • Study the causes and consequences of biological invasions and their management.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Apply the principles of taxonomic hierarchy and nomenclature to classify and identify various life forms. **CO2**: Evaluate the evolutionary processes and spatial and temporal patterns that influence biodiversity. **CO3**: Assess the economic, ecological, and social importance of

	biodiversity and ecosystem services. **CO4**: Identify the major threats to biodiversity and develop strategies for its conservation, including the role of local communities and traditional knowledge. **CO5**: Understand the mechanisms and impacts of biological invasions and propose management strategies to mitigate their effects. **CO6:** Examine global and national biodiversity policies, conventions, and frameworks, such as the Convention on Biological Diversity (CBD) and the Wildlife Protection Acts, and assess their role in biodiversity conservation.

Course Outline

Module	Description
I	**Concept of Taxonomic hierarchy and Nomenclature** Definition of systematics; taxonomic identification; keys; taxonomic literature; nomenclature; Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); taxonomic hierarchy, taxonomy databases, International Code of Botanical and Zoological Nomenclature; ranks and names; types and typification; principle classification schemes of Bentham and Hooker; Characters; variations; phenograms; cladograms; DNA barcoding; phylogenetic tree (rooted, unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly; homology and analogy; parallelism and convergence.
II	**From genes to ecosystems:** Tree of life; history of character transformation; organic evolution through geographic time scale; species concept – what's in a name?; how many species are there on earth?; concept and types of speciation. Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns; importance of biodiversity patterns in conservation. Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity; molecular techniques: RAPD, RFLP, AFLP; NCBI database, BLAST analyses.
III	**Importance of biodiversity:** Economic values – medicinal plants, drugs, fisheries and livelihoods; ecological services – primary productivity, role in hydrological cycle, biogeochemical cycling; ecosystem services – purification of water and air, nutrient cycling, climate control, pest control, pollination, and formation and protection of soil; social, aesthetic, consumptive, and ethical values of biodiversity.
IV	**Conservation Biogeography:** Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; land use

	changes; overgrazing; invasive species; man-wildlife conflicts; consequences of biodiversity loss. In-situ and Ex-situ conservation, role of local communities and traditional knowledge in conservation; biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book; ecological restoration: social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources. Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning. India as a mega-diversity nation; phytogeographic and zoogeographic zones of the country, National Biodiversity Action Plan.
V	**Biological invasions** Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Textbooks:

1. **Miller, G. T., & Spoolman, S. E.** (2020). *Environmental Science: Working with the Earth* (15th Edition). Cengage Learning.
2. **Sundar, I.** (2019). *Introduction to Systematics and Biodiversity: An Ecological Approach*. Springer.
3. **Gaston, K. J., & Spicer, J. I.** (2019). *Biodiversity: An Introduction* (3rd Edition). Wiley-Blackwell.
4. **Ricklefs, R. E., & Miller, G. L.** (2019). *Ecology* (10th Edition). Pearson.
5. **Primack, R. B.** (2014). *Essentials of Conservation Biology* (6th Edition). Sinauer Associates.

Reference Books:

1. **Schwartz, M. W.** (2020). *Biodiversity and Conservation: A Textbook for Students* (2nd Edition). Cambridge University Press.
2. **Wilson, E. O.** (2020). *The Diversity of Life* (25th Anniversary Edition). W.W. Norton & Company.
3. **Joppa, L. N., & Pimm, S. L.** (2021). *The Ecology of Invasive Species*. Springer.
4. **Barrett, L., et al.** (2021). *Ecology and Evolution of the Natural World*. Oxford University Press.

Program Outcome Vs Courses Mapping Table of Semester: V

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS301	Analytical methods, instrumentation, and Measurement	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	2	3	1	3	1	3	1	3
		CO	**2.3**	**1.5**	**2.0**	**2.5**	**2.0**	**1.8**	**1.7**	**2.0**	**1.7**	**2.0**
EVS302	Environmental Legislation and Environmental Impact Assessment	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	1	1	1	3	1	3	1	2	3
		CO	**2.0**	**1.5**	**1.5**	**2.4**	**2.3**	**1.5**	**2.2**	**1.4**	**1.8**	**2.0**
EVS303	Solid Waste Management	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	3	2	1	2	3	1	1	1	2
		CO	**2.5**	**1.8**	**2.0**	**2.2**	**2.2**	**1.8**	**1.7**	**1.7**	**1.7**	**1.8**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: V

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS301	Analytical methods, instrumentation, and Measurement	2	1	1	4	4
2.	CC	EVS302	Environmental Legislation and Environmental Impact Assessment	2	1	1	4	4
3.	CC	EVS303	Solid Waste Management	3	1	0	4	4
4.	Minor		Minor V (To be chosen from bucket provided)	3	1	0	4	4
5.	SEC		SEC IV (To be chosen from bucket provided)	2	0	0	2	2
6.	Internship	EVS304	Internship	0	0	0	4	4
	TOTAL						**22**	**22**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Analytical methods, instrumentation, and Measurement

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**V**
Course Title	**Analytical methods, instrumentation, and Measurement**
Course Code	**EVS301**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Introduce students to the fundamental principles of qualitative and quantitative analysis, including sampling, evaluation of analytical data, and error analysis. • Explore various titrimetric, optical, thermal, and electroanalytical methods, and their applications in environmental analysis. • Understand the principles and techniques of separation methods, including solvent extraction and chromatography, and their role in environmental monitoring. • Provide practical experience in the analysis of environmental samples using gravimetric, spectrophotometric, and chromatographic techniques. • Develop proficiency in the use of analytical instrumentation for the qualitative and quantitative determination of environmental pollutants.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Understand and apply the principles of qualitative and quantitative analysis, including sampling techniques, data evaluation, and error analysis.

	CO2: Utilize titrimetric, optical, thermal, and electroanalytical methods for the analysis of environmental samples, and understand the theoretical basis and practical applications of these techniques. **CO3**: Explain the principles, efficiency, and mechanisms of separation techniques such as solvent extraction and chromatography, and apply these methods to environmental analysis. **CO4**: Perform practical analyses of environmental samples, including water and air, using gravimetric, spectrophotometric, and chromatographic techniques. **CO5**: Operate and troubleshoot analytical instruments for the detection and quantification of pollutants in environmental samples. **CO6:** Evaluate and interpret analytical data from environmental monitoring, applying statistical methods to assess the accuracy, precision, and reliability of results for effective decision-making in environmental management.

Course outline

Module	Description
I	**Qualitative and quantitative aspects of analysis** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
II	**Titrimetric and Optical methods of analysis** Sampling, preservation, storage techniques; Principles and applications of titrimetry (Acidimetry, Alkalimetry, Complexometry, Argentometry, Iodometry) gravimetry, potentiometry, conductimetry. Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.
III	**Thermal and electroanalytical methods** Theory of thermogravimetry (TG), basic principle of instrumentation techniques for quantitative estimation of Ca and Mg from their mixture. Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

IV	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC,TLC and HPLC.

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

• Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H.Jeffery and others) 5th Ed. The English Language Book Society of Longman .

• Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed.WardsworthPublishing Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York,2004.

• Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

• Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

• Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis,Thomson Asia Pvt. Ltd

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Environmental Legislation and Environmental Impact Assessment

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**V**
Course Title	**Environmental Legislation and Environmental Impact Assessment**
Course Code	**EVS302**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To understand the historical development of environmental legislation and policies in India, including ancient traditions, medieval practices, and modern legal frameworks. • To familiarize students with key Indian environmental laws and regulations, and their role in safeguarding natural resources and biodiversity. • To explore major international environmental agreements and conventions that shape global environmental policy. • To develop skills in Environmental Impact Assessment (EIA), including methodologies and regulatory requirements for evaluating environmental impacts of projects. • To introduce students to risk assessment principles and practices, focusing on the identification, evaluation, and communication of environmental risks.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the historical evolution of environmental

	legislation in India, from the ancient period to post-independence, including key policies such as the National Forest Policy and Van Mahotsava. **CO2:** Analyze the significance of constitutional provisions and laws like the Environment (Protection) Act 1986 and the Wildlife (Protection) Act 1972 in promoting environmental conservation. **CO3:** Distinguish between major international environmental agreements, such as the Kyoto Protocol and the Montreal Protocol, and evaluate their relevance to contemporary environmental challenges. **CO4:** Apply Environmental Impact Assessment (EIA) techniques to assess the environmental consequences of development projects, including data collection and impact prediction methodologies. **CO5:** Assess environmental risks by conducting exposure assessments and hazard evaluations, considering the legal frameworks and regulations in place for risk management. **CO6:** Critically evaluate the role of non-governmental organizations (NGOs) and community-based organizations (CBOs) in shaping environmental policies, advocating for environmental justice, and contributing to grassroots conservation efforts in India and globally.

Course outline

Module	Description
I	**History of environmental legislation and policy** Ancient period: worship of water, air, trees; Mauryan period: Kautilya's Arthashastra, Yajnavalkyasmriti and Charaksamhita; Medieval period: forests as woodland and hunting resourcesduring Mughal reign; British India: Indian Penal Code 1860,Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953.
II	**Environmental legislation** Constitution of India; fundamental rights; fundamental duties; Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards and panchayats and municipal bodies in environmental law and policy making. 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). The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; 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, Concept of Ecomark and Ecolabelling.Case studies: National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991. Waste Management Rules 2016.
III	**International laws and policy** Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Outcomes of recent United Nations Climate Change Conferences (COPs); Ramsar convention. Basel Convention; Climate change and policy; Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.
IV	**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). EIA regulations in India-EIA Notification 2006, Status of EIA in India; Current issues in EIA regulation. Case study of hydropower projects/ thermal projects. Rapid EIA; 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 ISO14000; sustainable development.
V	**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. Concept of Ecomark and Ecolabelling

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.

2. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.

3. Divan, S. & Rosencranz, A. 2001. Environmental Law and Policy in India. Oxford University Press.

4. Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materials and Statues (2nd edition). Oxford University Press.

5. Gupta, K.R. 2006. Environmental Legislation in India. Atlantic Publishers and Distributors.

6. Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). Lexis Nexis India.

7. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.

8. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.

9. Barrow, C.J. 2000. Social Impact Assessment: An Introduction. Oxford University Press.

10. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.

11. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.

12. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Solid Waste Management

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**V**
Course Title	**Solid Waste Management**
Course Code	**EVS303**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** • To understand the generation, classification, and composition of various types of solid waste, including municipal, hazardous, and biomedical waste. • To assess the environmental and health impacts of improper solid waste and industrial waste disposal. • To evaluate different solid waste management techniques, such as collection, disposal, and treatment methods. • To analyze the importance of industrial waste management practices and pollution control methods. • To explore integrated waste management systems and resource recovery methods, including waste-to-energy conversion techniques.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the sources, types, and classification of solid waste, including municipal, hazardous, and biomedical waste, and their impact on the environment. **CO2:** Analyze the effects of solid waste and industrial waste disposal on soil, air, water, and human health, as well as assess the environmental risks associated with waste generation.

	CO3: Apply various solid waste management techniques such as landfill design, incineration, and waste collection and disposal methods, addressing the drawbacks and challenges of these techniques. **CO4:** Distinguish between different types of industrial waste (hazardous and non-hazardous) and evaluate the effectiveness of industrial waste treatment methods such as effluent treatment plants and emission control systems. **CO5:** Evaluate integrated waste management practices, including the 4Rs (reduce, reuse, recycle, recover), waste-to-energy technologies, and the role of legal frameworks in managing solid and industrial waste. **CO6:** Develop sustainable waste management strategies for communities, industries, and municipalities, incorporating principles of circular economy, community participation, and technological innovations for waste reduction, resource recovery, and environmental protection.

Course outline

Module	Description
I	**Introduction** Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.
II	**Effect of solid waste disposal on environment** Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.
III	**Solid waste Management** Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.
IV	**Industrial waste management** Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

V	**Resource Recovery** 4R's - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.
VI	**Waste-to-energy (WTE)** Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.
VII	**Integrated waste management** Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.
VIII	**Policies for solid waste management** Municipal Solid Wastes (Management and Handling) Rules 2016; Hazardous and other Wastes (Management and Transboundary Movement) 2016; Bio-Medical Waste Management Rules 2016; Plastic Waste Management Rules, 2016 and Plastic Waste Management (Amendment) Rules, 2018; E-Waste (Management) Rules, 2016 and E-Waste (Management) Amendment Rules, 2018.

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.

5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. &Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.

Program Outcome Vs Courses Mapping Table of Semester: VI

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS305	Evolutionary biology	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	2	2	3	1	2	2	2	1
		CO	**2.3**	**1.7**	**2.0**	**2.3**	**2.3**	**1.5**	**1.8**	**1.8**	**1.8**	**1.7**
EVS306	Environmental Biochemistry and Biotechnology	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	2	1	2	3	2	2	2	1	1
		CO	**2.0**	**1.7**	**1.5**	**2.6**	**2.3**	**1.7**	**2.0**	**1.6**	**1.6**	**1.6**
EVS307	Health, Safety and Environment	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	1	3	3	1	1	1	3	2
		CO	**2.3**	**1.7**	**1.8**	**2.5**	**2.3**	**1.5**	**1.7**	**1.7**	**2.0**	**1.8**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: VI

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS305	Evolutionary biology	3	1	0	4	4
2.	CC	EVS306	Environmental Biochemistry and Biotechnology	3	1	0	4	4
3.	CC	EVS307	Health, Safety and Environment	3	1	0	4	4
4.	Minor		Minor VI (To be chosen from bucket provided)	3	1	0	4	4
5.	SEC		SEC V (To be chosen from bucket provided)	2	0	0	2	2
6.	Project	EVS308	Project	0	0	4	4	4
	TOTAL						**22**	**22**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Evolutionary biology

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VI**
Course Title	**Evolutionary biology**
Course Code	**EVS305**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** • Determine the key events and processes involved in the origin and evolution of life, including the geological time scale, abiotic synthesis of biological molecules, and the emergence of unicellular organisms. • Analyze the structure and function of prokaryotic and eukaryotic cells, their metabolic pathways, and the role of cellular processes such as photosynthesis, respiration, and apoptosis. • Distinguish between different evolutionary mechanisms such as molecular divergence, gene duplication, genetic drift, and various forms of selection, and assess their impact on population genetics and speciation. • Examine the principles of biogeography, species distribution, niche differentiation, and the geographic and environmental factors that influence diversification, rarity, and invasion of species. • Apply evolutionary theories such as Darwin's Theory of Evolution, mutation theory, and the Hardy-Weinberg Law to solve practical problems related to population genetics, gene frequency, and evolutionary dynamics.
Course Outcome (CO)	**After completion of this course, students will be able to:**

	CO1: Understand the emergence of life, evolutionary history, and key events in the geological time scale, including concepts like the Oparin-Haldane hypothesis and the Urey-Miller experiment. **CO2:** Analyze cellular organization, metabolism, and processes such as photosynthesis, aerobic metabolism, and apoptosis in prokaryotic and eukaryotic cells. **CO3:** Distinguish between molecular evolutionary concepts like gene duplication, genetic drift, and types of selection, and apply them to population genetics and speciation. **CO4:** Apply biogeographical principles to understand species diversity, species-area relationships, and the impact of geographic and environmental factors on species evolution. **CO5:** Examine evolutionary laws and theories such as Hardy-Weinberg equilibrium, mutation theory, and Darwinian evolution, and solve problems related to gene frequency, allelic drift, and natural selection. **CO6:** Analyze the ecological and evolutionary interactions within ecosystems, including the role of natural selection, adaptation, niche theory, and species interactions in shaping community structure and biodiversity.

Course Outline

Module	Description
I	**Emergence of life and the evolutionary path:** Paleo-records of diversity and diversification; Paleontology and evolutionary History; Geological time scale; major events in the evolutionary time scale; Origin of life: abiotic synthesis of basic biological molecules, micelles, monomers and polymers; Oparin-Haldane hypothesis; study of Urey and Miller's experiment of early life on earth; the first cell and unicellular evolution,
II	**Basics of cellular organization and metabolism:** A. Prokaryotes cell and life processes; Cellular organization and functions, outer membrane of Gram-negative bacteria and its relevance in pathogenicity, anaerobic metabolism and electron transport, motility and quorum sensing, B. Evolution of eukaryotic metabolism; Origins of multicellular organisms. Eukaryotic cell organization, Membrane structure & transport; Anabolic and catabolic processes: photosynthesis and aerobic metabolism. Role of Mitochondria in eukaryotic metabolism energetic, Cell cycle - An overview of cell cycle and Programmed cell death (Apoptosis);
III	**Molecular evolution:** Neutral evolution; molecular divergence and molecular clocks; classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence. Concepts of populations, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection, Mendelism; spontaneity of mutations; migration and genetic drift; Concept of

	Kettlewall; Hardy-Weinberg Law; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent and divergent evolution; Concept of selection, Directional, Stabilising and Disruptive; sexual selection; coevolution.
IV	**Biogeography of Species evolution:** Species' habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; Island Biogeography theory; geography of diversification and invasion; biogeographical rules – Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species. De Vries' mutation theory, Synthetic theory of evolution; Concept of stasis; Punctuated Equilibrium Theory; Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness and natural selection;

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995. Molecular Cell Biology. W.H. Freeman.
2. Thorne, J. L., Kishino, H., & Painter, I. S. 1998. Estimating the rate of evolution of the rate of molecular evolution. Molecular Biology and Evolution 15: 1647-1657. 3. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, 2008. Prescott, Harley, and Klein's microbiology. 7th ed. McGraw-Hill.
4. Futuyma, D.J. 2009. Evolution (2nd edition). Sinauer Associates.
5. Gillespie, J. H. 1991. The Causes of Molecular Evolution. Oxford University Press.
6. Graur, D. & Li, W.H. 1999. Fundamentals of Molecular Evolution (2nd edition). Sinauer Associates.
7. Kimura, M. 1984. The Neutral Theory of Molecular Evolution. Cambridge University Press.
8. Nei, M. & Kumar, S. 2000. Molecular Evolution and Phylogenetics. Oxford University Press.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Environmental Biochemistry and Biotechnology

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VI**
Course Title	**Environmental Biochemistry and Biotechnology**
Course Code	**EVS306**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** • Understand the structure, functions, and biological significance of biomolecules such as carbohydrates, amino acids, proteins, nucleic acids, and lipids. • Analyze key biochemical pathways and cycles, including glycolysis, the TCA cycle, gluconeogenesis, and glycogen metabolism, along with their role in cellular energy production and regulation. • Identify effective ecological restoration and bioremediation techniques, such as wastewater treatment, solid waste management, and bioreactor applications for environmental cleanup. • Examine the use of ecologically safe products and processes, including biofertilizers, microbial insecticides, and biocontrol methods, and their importance in sustainable agriculture and biotechnology. • Apply laboratory skills in microbiology and biochemistry, such as bacterial isolation, DNA extraction, and the qualitative and quantitative analysis of biomolecules.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the structure and functions of key biomolecules

	such as carbohydrates, amino acids, proteins, nucleic acids, and lipids, including their biochemical properties and biological significance. **CO2:** Analyze important biochemical pathways, including glycolysis, the TCA cycle, and the pentose phosphate pathway, and their regulation in cellular metabolism. **CO3:** Apply techniques in ecological restoration and bioremediation, including wastewater and solid waste treatment processes, and evaluate the degradation pathways of pollutants such as hydrocarbons and heavy metals. **CO4:** Distinguish between ecologically safe products and processes, such as the use of biofertilizers, microbial insecticides, and biocontrol methods, and understand their role in sustainable agriculture and bio-patenting. **CO5:** Perform laboratory techniques related to microbiology and biochemistry, including culture preparation, bacterial enumeration, DNA extraction, and the qualitative analysis of biomolecules. **CO6:** Evaluate the role of microorganisms in environmental processes, including nutrient cycling, degradation of pollutants, and the maintenance of ecosystem health, and understand their applications in environmental biotechnology for sustainable development.

Course Outline

Module	Description
I	**Biomolecules:** Monosaccharides: Aldoses and ketoses, structure of D- glucose & D-fructose (configuration & conformation), anomeric effect, mutarotation. nature of glycosidic linkages; structure and systematic names of sucrose, lactose, maltose, Amino acids: Synthesis: (Strecker, Gabriel, acetamidomalonic ester, azlactone); isoelectric point, ninhydrin reaction. Peptides: peptide linkage, synthesis of peptides using N-protection & C-protection, solid phase synthesis; peptide sequence: C-terminal and N-terminal amino acid determination (Edman, Sanger & dansyl chloride). Primary, secondary, tertiary and quaternary structure of proteins and protein folding. Nucleic acids: pyrimidine & purine bases (only structure & nomenclature), nucleosides and nucleotides, DNA: Watson-Crick model, DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis. RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.; .Fatty acids- properties of saturated and unsaturated fatty acids. Esters of fatty acids-formation and hydrolysis; Essential fatty acids. Triacylglycerols. Reactions and characterization of fats Biological significance of fats. Cofactors – Definition, examples of a) metal ions b) coenzymes c) prosthetic group; Definition,

	examples of holoenzymes, Apoenzyme. Classification of enzymes, IUPAC system, Name & examples of each class Mechanism of enzyme activity Concept of Central Dogma
II	**Few important biochemical pathways and cycles:** Bioenergetics and Metabolism: Principles of Bioenergetics: Bioenergetics and Thermodynamics, Phosphoryl group transfers and ATP generation, Biological Oxidation and Reduction reaction. Intracellular metabolism of glucose - glycolysis, reaction and energetic of TCA cycle, (gluconeogenesis, glycogenesis, glycogenolysis, reactions and physiological significance of pentose phosphate pathway, regulation of glycolysis, TCA cycle, and glycogen metabolism).
III	**Ecological restoration and bioremediation** Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; treatment schemes for wastewater: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.
IV	**Ecologically safe products and processes** PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction. Basic concept of bio-patenting.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley Blackwell Publications.

2. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley & Sons.
3. Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995. Molecular Cell Biology. W.H. Freeman.
4. Nelson, D.L. & Cox, M.M. 2013. Lehninger's Principles of Biochemistry. W.H. Freeman.
5. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
6. Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
7. Snustad, D.P. & Simmons, M.J. 2011. Principles of Genetics (6th edition). John Wiley & Sons.
8. Wainwright, M. 1999. An Introduction to Environmental Biotechnology. Springer.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Health, Safety and Environment

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VI**
Course Title	**Health, Safety and Environment**
Course Code	**EVS307**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** 1. Understand the recognition, evaluation, and control of physical and chemical hazards, including noise, vibration, radiation, and various air contaminants, along with their effects and control measures. 2. Analyze occupational health issues, including injury evaluation, the role of medical services, personal protective equipment (PPE) requirements, and the management of work-related diseases and toxic exposures. 3. Identify proper personal hygiene practices and first aid concepts, focusing on hygiene maintenance, first aid requirements, emergency and non-emergency treatment, and exposure to hazardous materials. 4. Apply radiation protection principles, including radiation shielding, dose measurement, exposure limits, and effective control measures to manage radiation safety and waste disposal. 5. Evaluate safety audit procedures, including the definition and prevention of accidents, injury record analysis, and the development of effective safety audit practices to enhance workplace safety and compliance.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand and apply methods for recognizing, evaluating,

	and controlling physical and chemical hazards in the workplace, including noise, vibration, thermal stress, radiation, and various air contaminants. **CO2:** Analyze occupational health issues, including the evaluation of work-related injuries, the role and requirements of personal protective equipment (PPE), and the management of toxic exposures and occupational diseases. **CO3:** Identify and implement effective personal hygiene practices and first aid procedures, focusing on maintaining hygiene standards, emergency treatment, and handling exposures to hazardous materials. **CO4:** Evaluate and apply radiation protection principles, including radiation shielding, dose measurement, exposure limits, and the management of radioactive waste and environmental releases. **CO5:** Conduct and assess safety audits, including the identification of accident types, causes, and prevention methods, as well as the analysis of injury records and the development of effective safety audit procedures. **CO6:** Evaluate and apply principles of ergonomics in the workplace, focusing on the design of workstations, tools, and tasks to minimize physical strain, reduce injury risks, and enhance worker well-being and productivity.

Course Outline

Module	Description
I	**Physical and Chemical Hazards** Recognition, Evaluation and Control of Physical Hazards. Noise and Vibration: Effects and Control Measures, Thermal Stress, Parameter Control. Radiation: Types, Source: Effect and Control Illumination & Lighting. Recognition, Evaluation and Control of Chemical Hazards- Types - Dust-Fumes -Mist -Vapor-Fog etc., Air Contaminants- Evaluation - Types of Sampling-Air Sampling System-Method Analysis-Control Measures.
II	**Occupational Health** Evaluation of injuries: Medical services in industrial establishment, its function, action programs for work related diseases at the national level. Personal Protective Equipment: Introduction, requirements and assessment of PPE, types of PPE. Non-respiratory personal protective devices; head, ear, face and eye protection, feet and body protection, supply, use, care and maintenance of PPE, requirements under factory Acts and Rules. Respiratory PPE: Types of respiratory PPE, supply, use, care and maintenance of breathing apparatus, training for the use of breathing apparatus. Concept and Spectrum of Health-Functional Units and Activities of Occupational Health Services Occupational and Work-Related Disease-Levels of Prevention of Diseases - Notifiable Occupational Diseases such as Silicosis-

	Asbestosis- Pneumoconiosis-- Aluminosis and Anthrax. Lead-Nickel, Chromium and Manganese Toxicity-Gas Poisoning (such as CO, Ammonia, Coal Dust etc.,) their effects and Prevention- Cardiopulmonary Resuscitation- Audiology-Hearing Conservation Programme-Effects of Ultraviolet Radiation and Infrared Radiation on Human Systems Industrial Toxicology-Local and Systemic and Chronic Effects Temporary and Cumulative Effects Carcinogens Entry into Human System Ergonomics, Personnel Protective Equipment, Personnel Monitoring
III	**Personal Hygiene and First Aid** Hygiene Concepts: Correct and Clean Dresses, Clean Body, Washing, Good Habits, Oral and Stomach Hygiene: Cleaning, Compressed Air and Degreasing Agents, Long Hair and Nails and Torn and loosely Hanging Clothes, Smoking, Lavatories Maintenance, Living in Unhygienic Areas. First aid concept: First Aid Boxes, Legal Requirements, Industrial Hygiene, Medical Surveillance, Medical Surveillance Program Development, Recommended Medical Programme, Emergency Treatment, Non-Emergency Treatment, Exposures to Hazardous Materials.
IV	**Protection from radiation** Radiation Control: Radiation Shielding, Radiation Dose, Dose Measurements, Units of Exposure, Exposure Limits, Barriers for Control of Radioactivity Release, Control of Radiation Exposure to Plant Personnel, Health Physics Surveillance - Waste Management and Disposal Practices – Environmental, Releases.
V	**Safety audit** Definition of accidents: injury, types of accidents, causes and remedial measures, injury records, prevention, modes of prevention, physiological factors, Environmental Safety: Safety awareness, annual toll of industrial accidents in India, need for safety, legal, humanitarian factors impending safety, safety audit and steps to an effective safety audit.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Occupational Health and Safety Management: A Practical Approach, Third Edition, by Charles D. Reese.
2. Environmental Health and Safety Audits, Second Edition, by Lawrence B. Cahill.
3. Principles of Environmental Health and Safety Management, Second Edition, by Richard E. Fairfax.

4. Introduction to Environmental Health, Second Edition, by Jerome Nriagu.
5. Environmental Health and Safety for Hazardous Waste Sites, Second Edition, by Michael D. LaGrega.
6. Emergency Planning and Response for Libraries, Archives, and Cultural Institutions, by Johanna Wellheiser.
7. Hazardous Materials: Managing the Incident, Fourth Edition, by Christopher Hawley.
8. Fundamentals of Occupational Safety and Health, Sixth Edition, by Mark Friend and James Kohn.
9. Chemical Process Safety: Fundamentals with Applications, Third Edition, by Daniel A. Crowl and Joseph F. Louvar.
10. Industrial Hygiene Reference and Study Guide, Fourth Edition, by Marilyn E. Fingerhut and David M. Valiante.

Program Outcome Vs Courses Mapping Table of Semester: VII

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS401	Advanced Wastewater Engineering	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	2	2	3	3	2	2	2	2	1
		CO	**2.5**	**1.7**	**2.0**	**2.5**	**2.3**	**1.7**	**1.8**	**1.8**	**1.8**	**1.7**
EVS402	Air Pollution and Control Technologies	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	3	1	1	2	1	2	2	2	2
		CO	**2.0**	**1.8**	**1.5**	**2.4**	**2.2**	**1.5**	**2.0**	**1.6**	**1.8**	**1.8**
EVS403	Remote Sensing and Geographic Information System	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	1	1	1	3	2	3	2	2
		CO	**2.3**	**1.5**	**1.8**	**2.2**	**2.0**	**1.8**	**1.8**	**2.0**	**1.8**	**1.8**
EVS404	Research Methodology (should start working on dissertation topic)	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	3	2	3	1	2	2	3	2
		CO	**2.3**	**1.5**	**2.2**	**2.3**	**2.3**	**1.5**	**1.8**	**1.8**	**2.0**	**1.8**

EVS405	Environmental Sustainability	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	3	2	1	1	3	2	3	2	2
		CO	**2.7**	**1.8**	**2.0**	**2.2**	**2.0**	**1.8**	**1.8**	**2.0**	**1.8**	**1.8**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: VII

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS401	Advanced Wastewater Engineering	2	1	1	4	4
2.	CC	EVS402	Air Pollution and Control Technologies	2	1	1	4	4
3.	CC	EVS403	Remote Sensing and Geographic Information System	2	1	1	4	4
4.	CC (For With research)	EVS404	Research Methodology (should start working on dissertation topic)	2	1	1	4	4
5.	CC (For Without research)	EVS405	Environmental Sustainability	3	1	0	4	4
6.	Minor		Minor VII (To be chosen from bucket provided)	3	1	0	4	4
	TOTAL						**24**	**24**

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Advanced Wastewater Engineering

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VII**
Course Title	**Advanced Wastewater Engineering**
Course Code	**EVS401**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To understand the physical, chemical and biological characteristics of wastewater and their impact on treatment processes. • To analyze and apply preliminary and primary treatment processes, including physical and chemical unit operations for effective wastewater management. • To develop a strong foundation in secondary biological treatment processes, including biomass growth kinetics and nutrient removal techniques such as nitrogen and phosphorus reduction. • To evaluate and design advanced secondary treatment methods, including anaerobic processes and sludge treatment techniques for efficient sludge disposal. • To apply advanced wastewater treatment technologies such as membrane technology, MBR, and MBBR for achieving higher levels of water purification.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the physical, chemical, and biological

	characteristics of wastewater and their relevance to the selection of treatment processes. **CO2:** Apply knowledge of preliminary and primary treatment methods, including screening, grit removal, sedimentation, air flotation, and chemical processes like coagulation and precipitation for effective wastewater management. **CO3:** Analyze the principles of secondary treatment processes, including biomass growth kinetics, and evaluate advanced techniques for nutrient removal such as nitrogen and phosphorus elimination. **CO4:** Distinguish between various anaerobic and sludge treatment processes, and evaluate methods for efficient sludge disposal, including thickening, digestion, and filtration techniques. **CO5:** Apply advanced wastewater treatment technologies such as membrane filtration (MBR, MBBR) and evaluate their effectiveness in achieving high-quality effluent. **CO6:** Evaluate the role of integrated wastewater management strategies, including the use of resource recovery techniques like biogas production, water reuse, and the application of treated wastewater for irrigation or industrial purposes, ensuring sustainability and minimizing environmental impacts.

Course outline

Module	Description
I	**Basics of wastewater treatment** Physical, chemical and biological characteristics of wastewater.
II	**Preliminary and primary treatment** Analysis and selection of wastewater flow rates and constituent loadings for process design. Physical unit operations: Screening, grit chamber, sedimentation and air flotation. Chemical unit operations: coagulation, precipitation, chemical oxidation and scale control.
III	**Secondary Treatment** Biological treatment introduction, biomass growth kinetics. Advanced wastewater treatment: nutrient removal – Nitrogen and phosphorus removal, activated sludge processes and attached growth processes.
IV	**Advanced Secondary Treatment** Anaerobic treatment processes, sludge treatment and disposal: sources, characteristics and quantities of sludge. Treatment processes, gravity and flotation thickening, sludge digestion, vacuum and pressure filtration. Ultimate sludge disposal.
V	**Tertiary Treatment** Advanced treatment through membrane technology, MBR, MBBR technologies.

Evaluation :

Mode of Evaluation	Theory	
Weightage	Comprehensive and Continuous Assessment	End Semester Examination
	50%	50%

Text and Reference Books :

1. Metcalf and Eddy, “Wastewater Engineering”, 4th edition, McGraw-Hill, 2003.
2. Viessman and Hammer, “Water Pollution and Control”, 7th edition, Pearson Prentice Hall, 2004.
3. Hammer M.J. (2000): Water and wastewater technology. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Henze Harremoes La Cour Jansen, Arvin (1998): Wastewater treatment. Prentice Hall of India, USA.
5. Bristle, L.R. (1997): Theory and principles of water and wastewater treatment. John Willey and Sons, New Delhi.
6. Woodard, F. (2001): Industrial Waste Treatment Handbook. Butterworth Heinemonn, New Delhi.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Air Pollution and Control Technologies

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VII**
Course Title	**Air Pollution and Control Technologies**
Course Code	**EVS402**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To understand the sources, classification, and impacts of various air pollutants and their global implications on air quality and public health. • To apply techniques for the measurement of air pollutants, including representative sampling, source testing, and both batch and real-time measurement methods. • To analyze the influence of meteorological factors on air pollution dispersion, and apply atmospheric dispersion models for predicting pollutant concentrations. • To evaluate air pollution control devices for both particulate and gaseous pollutants, and understand technologies used for automotive emission control. • To assess the sources, effects, and control methods of noise, radiation, and odour pollution, and explore the technologies available for their measurement and

	reduction.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the history, composition, structure of the atmosphere, and global implications of air pollution, including the classification of pollutants such as particulates, hydrocarbons, carbon monoxide, oxides of sulphur, oxides of nitrogen, and photochemical oxidants. **CO2:** Explain the various sources of air pollution, air quality indices, emission standards, and methods for measuring air pollution, including techniques like representative sampling, real-time measurements, isokinetic sampling, and the use of high-volume samplers and cascade impactors. **CO3:** Analyse the role of meteorological phenomena in air quality, including the impact of atmospheric circulation patterns, stability, temperature inversions, and dispersion models (Gaussian model), and apply these concepts to assess air pollution levels and control measures in different environments. **CO4:** Evaluate air pollution control technologies for both particulate and gaseous contaminants, including devices like gravitational settling chambers, electrostatic precipitators, adsorption and absorption systems, and automotive emission control systems, and assess their effectiveness in reducing pollution. **CO5:** Assess the sources, impacts, and control measures of noise pollution, vibration, and radiation hazards in industrial and urban environments, with an understanding of their effects on human health and the methods for their measurement and control. **CO6:** Understand the causes, impacts, and control measures for odour pollution, including odour detection techniques like olfactometry and gas chromatography, and evaluate various odour pollution reduction technologies based on their effectiveness in reducing environmental nuisance.

Course outline

Module	Description
I	**Introduction** History of Air pollution; Composition and structure of the atmosphere; Global implication of air pollution; Units of measurement; Sources of air pollution; Classification of pollutants; Particulates, Hydrocarbons, Carbon monoxide, Oxides of Sulphur, Oxides of nitrogen, photochemical oxidants; Air quality index and air quality

	standards, emission standards
II	**Measurements of air pollution** Representative sampling; Source testing; Batch measurements; Real-time measurements; Mass concentration; Size distribution; Isokinetic sampling; hi-volume samplers and cascade impactors; Gas measurements
III	**Air pollution meteorology** Influence of meteorological phenomena on air quality: atmospheric circulation patterns, atmospheric stability and vertical mixing, lapse rate and temperature inversions; Atmospheric dispersions modelling: atmospheric stability classes, Gaussian model, estimation of downwind concentrations, plume rise, tall stacks, and critical wind speed. Computer modelling, point source models, mobile and line sources models
IV	**Air Pollution Control** Control devices for particulate contaminants: gravitational settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitators; Control devices for gaseous contaminants: adsorption, absorption, condensation, combustion, automotive emission control
V	**Noise Pollution** Industrial noise -Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise; Radiation Hazards: Types and effects of radiation on human body, Measurement and detection of radiation intensity, disposal of radioactive waste, Control of radiation, Vibration - effects, measurement and control measures.
VI	**Odour Pollution** Impacts of odour pollution; Odour as an Environmental Nuisance; Sources and dispersion of odours; Characteristics of Odour Molecules; Odour Dimensions (EPA, 2001); Odour pollution detection instrumentation; Olfactometry and Gas chromatography; Concepts of Total Odour Number (TON); Understanding Odour Characteristics; Molecular Mass, Volatility and Functional Groups; Odour Pollution Reduction Technologies.

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. De A.K., Environmental Chemistry, New Age International Publishers.

2. Manahan, S.E., Environmental Chemistry, Lewis Publishers.

3. Natusch, D.F.S. and Hopke, P.K., Analytical Aspects of Environmental Chemistry, John Wiley & sons.

4. Buch,W., Atmospheric Pollution, McGraw Hill.

5. Williamson, S.J., Fundamentals of Air Pollution, Addison-Wesley publishing Co.

6. Cadle, R.D. The Measurement of Air-borne Particles, John Wiley & sons.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Remote Sensing and Geographic Information System

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VII**
Course Title	**Remote Sensing and Geographic Information System**
Course Code	**EVS403**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To provide an in-depth understanding of the basic principles and concepts of remote sensing, including its historical evolution and its significance in India. • To familiarize students with the fundamentals of Geographic Information Systems (GIS), including spatial and non-spatial data structures, and the differences between raster and vector data models. • To equip students with the skills required to process, analyze, and interpret satellite data, including understanding the characteristics of different remote sensing systems and their applications. • To introduce practical applications of remote sensing and GIS in various fields such as geosciences, agriculture, water resource management, and land use planning, enhancing their problem-solving capabilities. • To develop proficiency in utilizing remote sensing and GIS software tools for spatial data analysis, including georeferencing, digitization, and creating spatial databases, as well as handling real-world data for thematic mapping and vector analysis.

Course Outcome (CO)	After completion of this course, students will be able to:
	CO1: Understand the fundamental concepts, principles, and historical development of Remote Sensing, including the interaction of Electromagnetic Radiation (EMR) with the atmosphere and Earth's surface, and the different resolutions (Spectral, Spatial, Temporal, Radiometric) associated with remote sensing systems. **CO2**: Analyze the differences between Geosynchronous and Sun-Synchronous Satellites, platforms, and sensor classifications (active and passive) and their applications. **CO3**: Distinguish between spatial and non-spatial data, as well as raster and vector data structures in GIS, and understand the basic principles of GIS and cartography, including map scale, grids, and data models. **CO4**: Apply remote sensing and GIS techniques to practical scenarios in geosciences, water resource management, agriculture, land use planning, and other environmental case studies. **CO5**: Perform hands-on practical skills in remote sensing and GIS software, including satellite image processing, georeferencing, digitization, and creating thematic maps and geodatabases for various spatial analysis tasks. **CO6:** Evaluate the integration of Remote Sensing and GIS technologies for advanced spatial analysis, including the use of multispectral and hyperspectral imagery, and assess their role in environmental monitoring, disaster management, and sustainable resource management.

Course outline

Module	Description
I	**Introduction to remote sensing** Principles of Remote Sensing – History, Development of RS in India, Concept & Principles, Electromagnetic Radiation (EMR) and Its characteristics, Interaction of EMR with Atmosphere and Earth's Surface, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions. Satellites and their Characteristics: Geo Synchronous and Sun Synchronous, Remote sensing systems, Platforms and their characteristics, Sensor classification: Active, Passive.
II	**Geographical Information Systems** Introduction to GIS: Definition, Philosophy & Historical evolution of GIS, Basic concepts about spatial information, Spatial vs. non-spatial data, Spatial data models – Raster and Vector, Components of GIS, Hardware/software requirements for GIS, GIS Vs Cartography, Basics of Cartography: Map Scale, Categories of Maps, Grids and Graticules.
III	**Data Structure** GIS Data structure and format : Raster Data & its Representation: Data Structure, Data

	Compression, Raster file formats, Vector data representation: Data Structure, Comparison between Raster & Vector Data. Data Acquisition through Scanners and Digitizers, Methods of Digitization (Manual vs. Automated), Geometric Transformations of Raster and Vector Data, RMS Error, Sources of Errors in spatial data and, Spatial Data Quality: Accuracy, Precision, Error and Uncertainty. Data reception and data products: Data Formats, Ground segment organization, Pre-processing, Referencing Scheme, Data product generation, Data product output medium, Open Data Sources
IV	**Applications and case studies** Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.
V	**Remote Sensing Practical** Familiarization with the various remote sensing software, downloading satellite data from various sources in the world wide web, displaying satellite image in different colour composites, Field Spectra Collection: vegetation, bare soil, and concrete using Spectro Radiometer and analyse it with satellite data, Extraction of Water bodies and Agricultural land use from a given satellite image, Discriminate Land surface features using spectral, thermal and microwave satellite images.
VI	**GIS practical** Familiarization with the GIS software, Georeferencing of spatial data in GIS software, Geodatabase creation and Digitization of point line and polygon features, Creation of Spatial data from Non-spatial data, Topology creation of spatial data, Removing topological error, Attribute data Integration with spatial data, Map Designing (layout creation), Thematic Map creation, Performing vector analysis; Attribute query, buffering, overlay.

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall Publications.

2. Edmondson, A. & Druce, D.1996. Advanced Biology Statistics. Oxford University Press.

3. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.

4. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.

5. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Research Methodology

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VII**
Course Title	**Research Methodology**
Course Code	**EVS404**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To provide a comprehensive understanding of research methodology in environmental science, from problem identification to hypothesis formulation. • To introduce students to various research designs and sampling techniques, emphasizing ethical considerations in conducting research involving humans and wildlife. • To familiarize students with a range of data collection methods, including surveys, interviews, field observations, laboratory experiments, and the use of remote sensing and GIS technologies. • To develop students' ability to analyze and interpret research data using both quantitative and qualitative methods, including statistical analysis and data visualization. • To equip students with the skills necessary for ethical research practices and effective scientific communication, including the preparation of research proposals, scientific papers, and presentations.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Understand the research methodology framework in

	environmental science, from identifying research problems to formulating research questions, objectives, and hypotheses. **CO2:** Analyze various research designs, including experimental, observational, and survey methods, and apply appropriate sampling techniques while considering ethical aspects in research. **CO3:** Apply different data collection methods, including questionnaires, interviews, field observations, laboratory experiments, and the use of remote sensing and GIS for environmental data. **CO4:** Interpret research data using descriptive and inferential statistics, as well as qualitative methods, and develop skills in data visualization techniques. **CO5:** Demonstrate knowledge of ethical principles in research and effectively communicate research findings through scientific writing, oral presentations, and visual aids such as posters. **CO6:** Evaluate and critically assess the validity and reliability of research findings in environmental science, including identifying potential biases, ensuring data integrity, and applying appropriate statistical models to draw meaningful conclusions and recommendations.

Course outline

Module	Description
I	**Introduction to Research Methodology** Overview of research methodology in environmental science, Research process: from problem identification to research questions, Formulating research objectives and hypotheses, Literature review and citation management
II	**Research Design and Sampling** Experimental, observational, and survey research designs, Sampling techniques and sample size determination, Ethical considerations in research involving human subjects and wildlife
III	**Data Collection Methods** Questionnaire design and survey methods, Interviews: structured, semi-structured, and in-depth, Field observations and data recording, Laboratory experiments and measurements, Remote sensing and GIS techniques for data collection
IV	**Data Analysis and Interpretation** Descriptive statistics: measures of central tendency and variability, Inferential statistics: hypothesis testing and significance, Qualitative analysis methods: content analysis, thematic analysis, Data visualization techniques
V	**Research Ethics and Integrity** Ethical principles in environmental research, Informed consent and confidentiality, Data management and integrity, Responsible authorship and

	publication ethics
VI	**Scientific communication of Research Proposal and finding** Components of a research proposal, Problem statement and research objectives, Methodology and study design, Project timeline and budget considerations, Scientific writing: structure and organization of research papers, Oral presentations and effective communication skills, Visual aids and poster presentations.

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
2. A. Keller
3. "Introduction to Environmental Impact Assessment: Principles and Procedures, Process, Practice, and Prospects" by John Glasson, Riki Therivel, and Andrew Chadwick
4. "Research Methods in Environmental Law: A Handbook" by Andreas Philippopoulos-Mihalopoulos
5. "Conservation Biology: Foundations, Concepts, Applications" by Fred Van Dyke

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Environmental Sustainability

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VII**
Course Title	**Environmental Sustainability**
Course Code	**EVS405**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** • To introduce the fundamental concepts and frameworks of environmental sustainability reporting, including the role of corporate social responsibility and sustainable development. • To equip students with knowledge of key environmental performance indicators and metrics such as carbon footprint, energy, water usage, and waste management. • To familiarize students with global standards and guidelines for environmental reporting, including GRI, SASB, TCFD, and Integrated Reporting. • To develop students' ability to collect, verify, and manage environmental data for sustainability reporting, ensuring transparency and preventing greenwashing. • To provide students with an understanding of carbon credits, emissions trading, and methodologies for evaluating carbon credit projects, along with effective communication strategies for

	reporting environmental performance.
Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1**: Understand the principles, frameworks, and importance of environmental sustainability reporting, including Corporate Social Responsibility (CSR) and sustainable development. **CO2**: Analyze key environmental performance indicators (KPIs) and metrics such as carbon footprint, water and energy consumption, and waste management. **CO3**: Distinguish between various environmental reporting standards and guidelines, including GRI, SASB, TCFD, and IR frameworks. **CO4**: Apply methodologies for collecting, verifying, and managing environmental data, ensuring transparency and preventing greenwashing in sustainability reporting. **CO5**: Evaluate carbon credit projects using appropriate methodologies, focusing on additionality, baseline determination, and co-benefits, and communicate environmental performance effectively through sustainability reports. **CO6:** Assess the role of stakeholders in environmental sustainability reporting, including investors, customers, and regulatory bodies, and develop strategies for improving corporate transparency and accountability in line with global sustainability goals.

Course outline

Module	Description
I	**Introduction to Environmental Sustainability Reporting** Overview of environmental sustainability reporting, Corporate social responsibility and sustainable development, Principles and frameworks for sustainability reporting (GRI, ISO 14001, etc.), Stakeholder engagement and materiality assessment
II	**Environmental Performance Indicators and Metrics** Key performance indicators for environmental sustainability reporting, Carbon footprint measurement and reporting, Water and energy consumption metrics, Waste management and recycling indicators
III	**Environmental Reporting Standards and Guidelines** Global Reporting Initiative (GRI) framework, Sustainability Accounting Standards Board (SASB) standards, Task Force on Climate-related Financial Disclosures (TCFD) recommendations, Integrated Reporting (IR) framework
IV	**Data Collection and Verification** Data collection methodologies and tools, Environmental data management systems, Independent assurance and verification of sustainability reports, Greenwashing and transparency in reporting

V	**Carbon Credits and Emissions Trading** Introduction to carbon credits and emissions trading, Kyoto Protocol and the Clean Development Mechanism (CDM), Verified Carbon Standard (VCS) and other carbon credit standards, Carbon offset projects and their types (renewable energy, afforestation, etc.)
VI	**Evaluating Carbon Credit Projects** Methodologies for evaluating carbon credit projects, Additionality and baseline determination, Social and environmental co-benefits of carbon credits, Case studies of successful carbon credit projects
VII	**Communication of Environmental Performance** Reporting environmental performance in sustainability reports, Effective communication strategies for environmental data, Stakeholder engagement in sustainability reporting, Reporting trends and future directions

Evaluation :

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books :

1. "Environmental Management Accounting for Cleaner Production" by Ayse Kucuk Yilmaz.
2. "Corporate Sustainability Reporting: The Global Reporting Initiative (GRI)" by Ralph Thurm, Nicky Amos, and Bastian Buck
3. "The Green to Gold Business Playbook: How to Implement Sustainability Practices for Bottom-Line Results in Every Business Function" by Daniel C. Esty and P.J. Simmons
4. "The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard" by World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)
5. "Carbon Markets: An International Business Guide" by Arnaud Brohé and Nick Eyre
6. "Environmental Finance: A Guide to Environmental Risk Assessment and Financial Products" by Sonia Labatt and Rodney R. White

Program Outcome Vs Courses Mapping Table of Semester: VIII

Course Code	Course Name	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
EVS406	Environmental Data Analysis and Statistics	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	2	3	1	2	3	1	3	3	3
		CO	**2.7**	**1.7**	**2.2**	**2.2**	**2.2**	**1.8**	**1.7**	**2.0**	**2.0**	**2.0**
EVS407	Advanced Environmental Modelling	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	3	3	2	3	1	3	3	3	3
		CO	**2.2**	**1.8**	**1.8**	**2.6**	**2.3**	**1.5**	**2.2**	**1.8**	**2.0**	**2.0**
EVS408	Advanced Eco-restoration Strategies	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	3	3	2	3	3	1	1	3	3
		CO	**2.5**	**1.8**	**2.2**	**2.3**	**2.3**	**1.8**	**1.7**	**1.7**	**2.0**	**2.0**

Correlation level 1, 2 and 3 as defined below:

"1" – Slight (Low)
"2" – Moderate (Medium)
"3" – Substantial (High)
"-" – No correlation

School of Basic and Applied Sciences

Department of Chemistry

BSc (NEP) Environmental Science

Batch: 2024-2025

Semester: VIII

S. No.	Type of Course	Course Code	Course Title	Teaching Load				CREDITS
				L	T	P	TOTAL	
1.	CC	EVS406	Environmental Data Analysis and Statistics	3	0	1	4	4
2.	CC (For Without Research)	EVS407	Advanced Environmental Modelling	3	1	0	4	4
3.	CC (For Without Research)	EVS408	Advanced Eco-restoration Strategies	3	1	0	4	4
4.	Minor		Minor VIII (To be chosen from bucket provided)	3	0	1	4	4
5.	Minor (For Without Research)		Minor IX (To be chosen from bucket provided)	3	0	1	4	4
6.	Dissertation (For with research)	EVS409	Project/Dissertation	0	0	12	12	12
	TOTAL							

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Environmental Data Analysis and Statistics

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VIII**
Course Title	**Environmental Data Analysis and Statistics**
Course Code	**EVS406**
Credit	**4**
Contact Hours (L-T-P)	**3-0-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • To apply data visualization techniques and descriptive statistics to analyze and interpret environmental data distributions effectively. • To utilize R programming for data manipulation, analysis, and visualization, including importing/exporting data, working with data structures, and using packages. • To analyze and perform data screening procedures, including handling missing data, detecting outliers, and applying data transformations and standardizations. • To evaluate environmental data using deterministic functions and probability distributions to model ecological processes and test hypotheses. • To implement resampling methods, such as bootstrapping and randomization tests, and perform stochastic simulations to analyze ecological and environmental processes.

Course Outcome (CO)	After completion of this course, students will be able to:
	CO1: Students will be able to understand data visualization techniques, descriptive statistics, and distributions to effectively interpret environmental datasets. **CO2:** Students will be able to apply R programming skills for data analysis, including importing/exporting data, performing statistical operations, and generating plots. **CO3:** Students will be able to analyze data by performing screening and adjustment procedures, including handling missing data, detecting outliers, and applying transformations. **CO4:** Students will be able to distinguish between different deterministic functions and probability distributions, and utilize them to model and analyze ecological processes. **CO5:** Students will be able to implement resampling methods and stochastic simulations, and evaluate their use in analyzing static and dynamic environmental processes. **CO6:** Students will be able to interpret the results of statistical analyses in the context of environmental science, communicate findings effectively through visualizations, and make data-driven decisions to inform sustainable environmental practices.

Course Outline

Module	Description
I	**Introduction** Data visualization, and distributions, Objectives, overview and organization, Visualizing distributions, Descriptive statistics, robust measures.
II	**Introduction to R** What is R, Installation of R, A Few Important Syntax Conventions in R, Variables and Types, Data Structures, R Operators, Creating Subsets of a Matrix or Data Frame, Row or Column Operations on a Matrix or Data Frame Functions in R, Getting Data Into and Out of R, Plotting in R, Getting Help in R, Libraries and Packages, Tutorials for Learning R
III	**Data screening and adjustments** Summary statistics (e.g., means, standard deviations, quantiles), Missing data (e.g., single variable and multi-variable imputation), Frequency of occurrence and abundance plots, Dropping variables, Single variable distributions, Relationships between pairs of variables, Outliers, Data transformations, Data standardizations, Dissimilarity matrices
IV	**Analysis of Environmental Data** Deterministic functions, What is a deterministic (mathematical) function, Linear function – Example of local faunal species, Logistic function – Example of local

	faunal species, Ricker function , Bestiary of deterministic functions
V	**Probability distributions** What is a probability distribution, Plotting distributions, Bestiary of probability distributions, Classical tests:, Single sample, Two samples
VI	**Resampling procedures and stochastic simulations** Bootstrap, Randomization tests, Stochastic simulations, Simulating static ecological processes, Simulating dynamic processes – population matrix mode

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text and Reference Books:

1. **Miller, I. and Freund, J. E.** (9th Edition). *Probability and Statistics for Engineers*
2. **Sokal, R. R. and Rohlf, F. J.** (2012). *Biometry: The Principles and Practice of Statistics in Biological Research* (4th Edition).
3. **Zar, J. H.** (2010). *Biostatistical Analysis* (5th Edition).
4. **Helsel, D. R., and Hirsch, R. M.** (2002). *Statistical Methods in Water Resources* (Studies in Environmental Science 49).
5. **Montgomery, D. C. and Runger, G. C.** (2010). *Applied Statistics and Probability for Engineers* (5th Edition).
6. **Manly, B. F. J.** (2006). *Statistics for Environmental Science and Management*
7. **Larsen, L. L., and Marsden, M. A.** (2015). *Environmental Statistics and Data Analysis*

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Advanced Environmental Modelling

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VIII**
Course Title	**Advanced Environmental Modelling**
Course Code	**EVS407**
Credit	**4**
Contact Hours (L-T-P)	**3-1-0**
Course Type	**Theory**
Course Objective	**The objectives of this course are** • **Understand** the scope, importance, and types of environmental models, including deterministic, stochastic, and spatial models, and their applications in environmental science. • **Explore** mathematical and statistical modelling techniques, such as differential equations, regression analysis, and dynamic equilibrium models, to simulate environmental processes and population dynamics. • **Evaluate** different spatial modelling techniques and geostatistical methods, including kriging, spatial autocorrelation, and variograms, for analyzing environmental data using GIS tools. • **Examine** agent-based modelling frameworks and their applications in ecology and social sciences, focusing on the design, implementation, and validation of these models. • **Analyze** the integration of environmental models with decision support systems, conducting sensitivity and uncertainty analyses to communicate model results to stakeholders effectively.

Course Outcome (CO)	After completion of this course, students will be able to:
	CO1: Understand the scope, importance, and types of environmental models, including deterministic, stochastic, and spatial models, and their components. **CO2**: Apply mathematical models using differential and difference equations to analyze environmental systems, including population dynamics and mass balance. **CO3**: Analyze environmental data using statistical modelling techniques such as linear and nonlinear regression, model selection, and validation. **CO4:** Evaluate spatial modelling techniques using GIS, including spatial interpolation, geostatistics, and spatial prediction. **CO5:** Implement agent-based models and integrate environmental models with decision support systems, while addressing model uncertainty, sensitivity, and ethical considerations. **CO6:** Assess the effectiveness and limitations of environmental models in addressing real-world problems, such as climate change, pollution, and conservation, and propose improvements for model refinement and practical applications.

Course Outline

Module	Description
I	**Introduction to Environmental Modelling** Overview of environmental modelling: scope and importance, Types of environmental models: deterministic, stochastic, spatial, etc. Model components: structure, inputs, processes, and outputs, Model classification based on temporal and spatial scales
II	**Mathematical Modelling** Introduction to mathematical models: differential equations, difference equations, and systems dynamics, Compartmental models: mass balance and rate equations, Dynamic equilibrium models: exponential growth and decay models, Ecological modelling: population dynamics and food web models
III	**Statistical Modelling and Regression Analysis** Introduction to statistical modelling in environmental science, Linear and nonlinear regression analysis Model selection and validation techniques, Multivariate analysis and regression diagnostics
IV	**Spatial Modelling and Geographical Information Systems** Introduction to spatial modelling and GIS in environmental science, Spatial interpolation techniques: kriging, inverse distance weighting, etc., Geostatistics:

	variograms, spatial autocorrelation, and spatial prediction, Introduction to raster and vector data analysis
V	**Agent-Based Modelling** Introduction to agent-based modelling (ABM), Agent-based modelling frameworks and applications in ecology and social sciences, Designing and implementing agent-based models, Model calibration and validation in agent-based modelling.
VI	**Environmental Modelling Tools and Software** Overview of commonly used environmental modelling software and tools (e.g., STELLA, AQUATOX, SWAT), Introduction to programming languages for environmental modelling (e.g., R, Python), Model visualization and interpretation of results.
VII	**Model Integration and Decision Support Systems** Integration of environmental models with decision support systems, Model uncertainty and sensitivity analysis, Communicating model results to stakeholders and decision-makers, Ethical considerations and limitations of environmental modelling.

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Textbooks:

1. Strifling, W. J. (2001). *Environmental modeling: Fate and transport of pollutants in water, air, and soil*. Wiley-Interscience.
2. Anastasopoulos, D. A. L., & Hatzikraniotis, P. K. (Eds.). (2018). *Introduction to environmental modelling*. Springer.
3. Borsuk, P. H. V. E., & Hopfensperger, E. J. (2014). *Environmental systems and decision support*. John Wiley & Sons.
4. Rizzo, M. J. S. L. (2007). *Applied environmental modeling*. Academic Press.
5. Norse, A. J. (2012). *Ecological modeling: Data analysis and simulation of ecological systems*. Elsevier.
6. Rao, S. S. (2011). *Environmental modelling with MATLAB*. Elsevier.

Reference Books:

1. Wilson, J. P. (2008). *Principles of environmental modeling*. Oxford University Press.
2. Lee, D. A. H. (2002). *Mathematical models in environmental science*. Cambridge University Press.
3. McLeod, R. J., & Crain, D. J. (2004). *Statistical methods in environmental science*. Wiley-Interscience.
4. Fisher, P., & Unwin, D. (Eds.). (2005). *Geographical information systems for environmental modelling*. Wiley.
5. Railsback, S. F., & Grimm, V. (2012). *Agent-based and individual-based modeling: A practical introduction*. Princeton University Press.
6. Brouwer, J. H. (2006). *Handbook of environmental and ecological modelling*. Springer.
7. Kitching, R. I. (2011). *Simulation and modeling of ecological systems*. Springer.

SYLLABUS

B.Sc. ENVIRONMENTAL SCIENCE

Advanced Eco-restoration modeling

School	**SCHOOL OF BASIC AND APPLIED SCIENCES**
Programme/Discipline	**B.Sc.**
Batch	**2024-25**
Semester	**VIII**
Course Title	**Advanced Eco-restoration modeling**
Course Code	**EVS408**
Credit	**4**
Contact Hours (L-T-P)	**2-1-1**
Course Type	**Hybrid**
Course Objective	**The objectives of this course are** • Understand the definition, scope, and historical development of ecological restoration, including its importance in addressing environmental challenges and its ethical considerations. • Explore methods for assessing ecosystem health and restoration potential, and develop strategies for designing and implementing effective restoration plans. • Evaluate different restoration techniques and approaches, including passive vs. active restoration and various soil, plant, and habitat restoration methods. • Examine the role of stakeholder engagement in restoration projects, focusing on incorporating local knowledge, addressing conflicts, and building effective partnerships. • Analyze emerging trends in eco-restoration, such as climate change resilience, invasive species management, and sustainable financing, by reviewing successful and challenging restoration projects across various ecosystems.

Course Outcome (CO)	**After completion of this course, students will be able to:** **CO1:** Apply various methods for assessing ecosystem health and restoration potential to design effective restoration plans. **CO2:** Analyze different restoration techniques and approaches, including passive vs. active restoration, and their suitability for various ecosystems. **CO3:** Distinguish between rehabilitation, reclamation, and rewilding, and select appropriate strategies for different restoration scenarios. **CO4:** Understand the role of stakeholder engagement in restoration projects, including how to incorporate local knowledge, address conflicts, and build partnerships. **CO5:** Evaluate emerging trends in eco-restoration, such as climate change resilience and invasive species management, by reviewing case studies and identifying lessons learned from successful and challenging projects. **CO6:** Integrate monitoring and adaptive management techniques into restoration projects to ensure long-term sustainability and effectiveness in achieving ecological goals.

Course Outline

Module	Description
I	**Introduction to Eco-restoration** Definition and scope of ecological restoration; Historical development of the field; Importance of ecological restoration in addressing environmental challenges; Causes and drivers of ecosystem degradation (e.g., habitat loss, pollution); Impacts of degradation on biodiversity and ecosystem services; Case studies of degraded ecosystems; Ethical considerations in eco-restoration
II	**Ecosystem Assessment and Planning** Methods for assessing ecosystem health and restoration potential; Identifying restoration goals and objectives; Designing restoration plans and strategies; Passive vs. active restoration approaches; Rehabilitation vs. reclamation vs. rewilding; Selecting appropriate restoration strategies for different ecosystems
III	**Ecological Succession and Restoration Techniques** Understanding ecological succession and its relevance to restoration; Soil restoration and remediation techniques; Plant selection, propagation, and establishment in restoration projects; Wetland and riparian habitat restoration techniques; Species Reintroduction and Management; Reintroduction programs for endangered and threatened species; Habitat requirements and captive breeding techniques;Monitoring and adaptive management for reintroduced populations

IV	**Stakeholder Engagement in Restoration Projects** Identifying and engaging relevant stakeholders in restoration initiatives; Incorporating local knowledge and community participation; Addressing conflicts and building partnerships in restoration projects; Monitoring and Assessment in Ecological Restoration; Importance of monitoring and evaluation in restoration projects; Data collection methods and indicators of restoration success; Adaptive management and feedback loops in restoration
V	**Emerging Trends in Eco-restoration** Climate change and resilience in restoration; Invasive species management in restoration projects; Sustainable financing and fundraising for restoration initiatives; Analyzing successful restoration projects in different ecosystems (e.g., forests, wetlands, coral reefs); Lessons learned from restoration failures and challenges; Ethical considerations and social justice in restoration efforts

Evaluation:

Mode of Evaluation	**Theory**	
Weightage	**Comprehensive and Continuous Assessment**	**End Semester Examination**
	50%	**50%**

Text Books:

1. **Clewell, A. F., & Aronson, J. (2006).** *Ecological restoration: Principles, values, and structure of an emerging profession.* Island Press.
2. **Hobbs, R. J., & Harris, J. A. (2001).** *Restoration ecology: Repairing the Earth's ecosystems in the new millennium.* Restoration Ecology, 9(2), 239-246.
3. **Perrow, M. R., & Davy, A. J. (2002).** *Handbook of ecological restoration: Volume 1: Theories and applications.* Cambridge University Press.
4. **Menz, M. H. M., Dixon, K. W., & Hobbs, R. J. (2013).** *Restoration ecology: The challenge of managing ecosystems in the face of global change.* John Wiley & Sons.
5. **Barton, D. N., & Lindhjem, H. (2012).** *The economics of ecosystem restoration.* Routledge.

Reference Books:

1. **Suding, K. N., & Hobbs, R. J. (2009).** *New models for ecosystem-based restoration: Using principles from ecology and economics for improving ecological restoration success.* Cambridge University Press.
2. **Davis, M. A., & Slobodkin, L. B. (2004).** *The science and practice of restoration ecology.* Restoration Ecology, 12(1), 1-3.

3. **Young, T. P., & Thompson, J. L. (2014).** *Ecological restoration: Science and policy.* Springer.
4. **Zedler, J. B., & Kercher, S. (2005).** *Wetland restoration: The science and practice of ecological restoration.* Island Press.
5. **Pereira, H. M., & Navarro, L. M. (2015).** *The role of biodiversity in ecosystem restoration: A global perspective.* Springer.
6. **Kramer, A., & Boyle, M. (2010).** *Restoration of riparian and wetland ecosystems: Case studies from the Northern Great Plains.* Springer.

Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS101	Ecology and Ecosystems	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	1	1	2	1	3	3	2	1	1
		CO	2.7	1.5	1.8	2.3	2.0	1.8	2.0	1.8	1.7	1.7
EVS102	Energy and Environment	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	1	1	2	1	2	3	2	2	2
		CO	2.0	1.5	1.5	2.6	2.0	1.7	2.2	1.6	1.8	1.8
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS103	Physics and Chemistry of the	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2

	Environment	CO6	3	2	3	3	1	3	3	1	3	2
		CO	**2.7**	**1.7**	**2.2**	**2.5**	**2.0**	**1.8**	**2.0**	**1.7**	**2.0**	**1.8**
EVS104	Atmospheric science and Climate Change	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	3	3	3	3	2	1	1	3	2	2
		CO	**2.3**	**1.8**	**1.8**	**2.8**	**2.2**	**1.5**	**1.8**	**1.8**	**1.8**	**1.8**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS201	Water And Water Resources Management	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	3	1	2	2	2	3	2	1
		CO	**2.3**	**1.7**	**2.2**	**2.2**	**2.2**	**1.7**	**1.8**	**2.0**	**1.8**	**1.7**
EVS202	Land and Soil Conservation and Management	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	3	2	2	2	3	2	3	1	1
		CO	**2.2**	**1.8**	**1.7**	**2.6**	**2.2**	**1.8**	**2.0**	**1.8**	**1.6**	**1.6**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS203	Environmental Pollution and Human health	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2

		CO6	3	3	3	3	3	1	3	1	1	1
		CO	**2.7**	**1.8**	**2.2**	**2.5**	**2.3**	**1.5**	**2.0**	**1.7**	**1.7**	**1.7**
EVS204	Earth and Earth Surface Processes	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	1	3	1	2	3	2	2	2	1
		CO	**2.2**	**1.5**	**1.8**	**2.4**	**2.2**	**1.8**	**2.0**	**1.6**	**1.8**	**1.6**
EVS205	Natural Resource Management and Sustainability	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	3	3	2	3	3	1	1	3	1
		CO	**2.7**	**1.8**	**2.2**	**2.3**	**2.3**	**1.8**	**1.7**	**1.7**	**2.0**	**1.7**
EVS206	Systematics and Biodiversity	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	3	1	3	1	2	3	2	1
		CO	**2.3**	**1.7**	**2.2**	**2.2**	**2.3**	**1.5**	**1.8**	**2.0**	**1.8**	**1.7**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS301	Analytical methods, instrumentation, and Measurement	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	2	3	1	3	1	3	1	3
		CO	**2.3**	**1.5**	**2.0**	**2.5**	**2.0**	**1.8**	**1.7**	**2.0**	**1.7**	**2.0**
		CO1	2	2	1	3	2	1	2	1	1	2

EVS302	Environmental Legislation and Environmental Impact Assessment	CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	1	1	1	3	1	3	1	2	3
		CO	**2.0**	**1.5**	**1.5**	**2.4**	**2.3**	**1.5**	**2.2**	**1.4**	**1.8**	**2.0**
EVS303	Solid Waste Management	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	3	2	1	2	3	1	1	1	2
		CO	**2.5**	**1.8**	**2.0**	**2.2**	**2.2**	**1.8**	**1.7**	**1.7**	**1.7**	**1.8**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS305	Evolutionary biology	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	2	2	3	1	2	2	2	1
		CO	**2.3**	**1.7**	**2.0**	**2.3**	**2.3**	**1.5**	**1.8**	**1.8**	**1.8**	**1.7**
EVS306	Environmental Biochemistry and Biotechnology	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	2	1	2	3	2	2	2	1	1
		CO	**2.0**	**1.7**	**1.5**	**2.6**	**2.3**	**1.7**	**2.0**	**1.6**	**1.6**	**1.6**
EVS307	Health, Safety and	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1

	Environment	CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	2	1	3	3	1	1	1	3	2
		CO	**2.3**	**1.7**	**1.8**	**2.5**	**2.3**	**1.5**	**1.7**	**1.7**	**2.0**	**1.8**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS401	Advanced Wastewater Engineering	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	2	2	3	3	2	2	2	2	1
		CO	**2.5**	**1.7**	**2.0**	**2.5**	**2.3**	**1.7**	**1.8**	**1.8**	**1.8**	**1.7**
EVS402	Air Pollution and Control Technologies	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	1	3	1	1	2	1	2	2	2	2
		CO	**2.0**	**1.8**	**1.5**	**2.4**	**2.2**	**1.5**	**2.0**	**1.6**	**1.8**	**1.8**
EVS403	Remote Sensing and Geographic Information System	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	1	1	1	3	2	3	2	2
		CO	**2.3**	**1.5**	**1.8**	**2.2**	**2.0**	**1.8**	**1.8**	**2.0**	**1.8**	**1.8**
EVS404	Research Methodology (should start working on dissertation topic)	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	1	1	3	2	3	1	2	2	3	2
		CO	**2.3**	**1.5**	**2.2**	**2.3**	**2.3**	**1.5**	**1.8**	**1.8**	**2.0**	**1.8**

EVS405	Environmental Sustainability	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	3	2	1	1	3	2	3	2	2
		CO	**2.7**	**1.8**	**2.0**	**2.2**	**2.0**	**1.8**	**1.8**	**2.0**	**1.8**	**1.8**
Course Code	**Course Name**	**COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**
EVS406	Environmental Data Analysis and Statistics	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	3	2	3	1	2	3	1	3	3	3
		CO	**2.7**	**1.7**	**2.2**	**2.2**	**2.2**	**1.8**	**1.7**	**2.0**	**2.0**	**2.0**
EVS407	Advanced Environmental Modelling	CO1	2	2	1	3	2	1	2	1	1	2
		CO2	2	1	3	-	2	3	2	-	2	-
		CO3	2	2	1	2	2	1	2	2	1	2
		CO4	2	1	1	3	2	2	2	1	3	1
		CO5	3	2	2	3	3	1	2	2	-	2
		CO6	2	3	3	2	3	1	3	3	3	3
		CO	**2.2**	**1.8**	**1.8**	**2.6**	**2.3**	**1.5**	**2.2**	**1.8**	**2.0**	**2.0**
EVS408	Advanced Eco-restoration Strategies	CO1	2	2	3	3	2	1	2	1	3	3
		CO2	2	1	1	2	2	2	2	2	2	1
		CO3	3	2	2	2	2	2	2	2	2	2
		CO4	3	1	2	3	2	2	2	1	1	1
		CO5	3	2	2	2	3	1	1	3	1	2
		CO6	2	3	3	2	3	3	1	1	3	3
		CO	**2.5**	**1.8**	**2.2**	**2.3**	**2.3**	**1.8**	**1.7**	**1.7**	**2.0**	**2.0**