Appendix-LXXII
Resolution No. 18 [18-1(18-1-3)]

UNIVERSITY OF DELHI

B.SC. (H) ENVIRONMENTAL SCIENCE

(SEMESTER-I)
based on

Undergraduate Curriculum Framework 2022 (UGCF)

(Effective from Academic Year 2022-23)

University of Delhi

List of DSC Papers

DSC-1: Environmental and Earth Surface Processes

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/
			L	T	P	
Environmental and Earth Surface Processes	DSC-1	4	2	0	2	Class XII Pass

Contents of the course and reference is in Annexure-I

DSC-2: Environmental Physics

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/
			L	T	P	
Environmental Physics	DSC-2	4	2	0	2	Class XII Pass

Contents of the course and reference is in Annexure-II

DSC-3: Environmental Chemistry

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/
			L	T	P	
Environmental Chemistry	DSC-3	4	2	0	2	Class XII Pass

Contents of the course and reference is in Annexure-III

UNIVERSITY OF DELHI

Generic Electives in BSC(Hons.) Environmental Science

(ODD Semester)

based on

Undergraduate Curriculum Framework 2022 (UGCF)

(Effective from Academic Year 2022-23)

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/Prerequisite	**Course content and structure is at**
			L	**T**	**P**		
Environment and Society	GE-01		**2**	**0**	**2**		**Annexure-IV**
Human Wildlife Conflict and Management	GE-02		**2**	**0**	**2**		**Annexure-V**
Gender and Environment	GE-03		**2**	**0**	**2**		**Annexure-VI**
Green Technologies	GE-04		**2**	**0**	**2**		**Annexure-VII**

DSC-EVS-1: ENVIRONMENTAL AND EARTH SURFACE PROCESSES

Theory (02 Credits: 30 lectures) + Practicals/Hands-on Exercises (02 Credits: 60 hours)

Course objectives:

- Introduce students to the basic structure and composition of the Earth
- Explore various surface processes and their impact on and role in living systems
- Analyze interactive processes in the inner as well as outer Earth's surface.

Theory (02 Credits: 30 lectures)

Unit 1: History of Earth (5 lectures)

Solar system formation and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; Geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans, role of humans in shaping landscapes; development of cultural landscapes.

Unit 2: Earth system processes (5 lectures)

Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hot spots; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; continental drift and present-day continents, paleontological evidences of plate tectonics; continental collision and formation of the Himalaya and mountains.

Unit 3: Minerals and rocks (7 lectures)

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: factors and agents of erosion; rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.

Unit 4: Earth surface processes (8 lectures)

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.

Unit 5: Importance of being a mountain (5 lectures)

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, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises Based on the theory (02 Credits: 60 hours)

1. Field survey and learning what and how are to be collected, observed, and recorded as a young field environmental geologist.
2. Field visit to identify natural agents derived landform and geomorphic features.
3. Field surveys and learning indicators of geomorphology, external features, texture, colour, mineral composition, and minerals to identify the rock types
4. Mapping of igneous, sedimentary, and metamorphic rocks and drawing sketches to highlight important features of different rock types
5. Megascopic identification of mineral samples: bauxite, calcite, chalcopyrite, feldspar, galena, gypsum, hematite, magnetite, mica, quartz, talc, tourmaline;
6. Estimate the relative density of soil and conduct sedimentation analysis using hydrometer method.
7. Determine plastic limit of soil and determine soil permeability
8. Study any glacier, its flow direction, identification of glacial erosional and depositional landforms, and analysis.
9. Read, prepare and interpret geological maps to analyze petrographical and structural features
10. Read and interpret topographical maps, aerial photographs, satellite imagery, and digital elevation models for the earth's surface features
11. Locate the epicenter of an earthquake
12. Interpret earth's history using igneous and sedimentary rocks

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Learning outcomes:

After this course, students will be able to

- Acquire environmental field mapping skills to identify rocks, landforms, soils, and minerals
- Analyze surface and near-surface processes and products;
- Develop the current status of earth's processes while correlating it with global changes through time.
- Correlate landform and environmental conditions based on the evolution of the earth
- Relate and interpret the geological history of an area based on rock analyses
- Use satellite data to interpret Earth's geology or landscape

Suggested Readings

- Bridge, J., & Demicco, R. 2008. *Earth Surface Processes, Landforms and Sediment Deposits*. Cambridge University Press.
- Cronin, V.S., 2018. Laboratory Manual in Physical Geology. Pearson.
- Keller, E.A. 2011. *Introduction to Environmental Geology* (5th edition). Pearson Prentice Hall.
- Leeder, M., Arlucea, M.P. 2005. *Physical Processes in Earth and Environmental Sciences.* Blackwell Publishing.
- Ludman, A. and Marshak, S., 2010. Laboratory manual for introductory geology (p. 480). WW Norton & Company.
- McCann, T., 2021. Pocket Guide Geology in the Field. Springer, Bonn, Germany.
- Pelletier, J. D. 2008. *Quantitative Modeling of Earth Surface Processes* (Vol. 304). Cambridge: Cambridge University Press. Chicago.
- Rutford, R.H., and Carter, J.L., 2018. Zumberge's Laboratory Manual for Physical Geology, Sixteenth Edition, Mc-Graw-Hill Education, New York, USA.

DSC-EVS-2: ENVIRONMENTAL PHYSICS

Theory (02 Credits: 30 lectures) + Practicals/Hands-on Exercises (02 Credits: 60 hours)

Course objectives:

- Build conceptual understanding of the environment by understanding the underlying principles of physics governing environmental processes
- Develop perspective on the concepts of physics associated with the movement of particles, chemicals, and gaseous across the environmental compartments
- Gain insights into physics of plant-soil-water interface determining ecosystem processes

Theory (02 Credits: 30 lectures)

Unit 1: Environmental spectroscopy (5 lectures)

Basic concepts of light and matter; quantum mechanics (relation between energy, wavelength and frequency), black body radiation, Kirchhoff's law, Boltzmann equation, Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic and solar cells.

Unit 2: Ocean and atmosphere (6 lectures)

Oceanic waves and circulation, Atmospheric temperature, pressure, circulation, precipitation and other features, Lapse rate (dry and moist adiabatic), Scattering of light, Rayleigh and Mie scattering, Electromagnetic radiations and spectrum, Greenhouse effect.

Unit 3: Soil and water physics (7 lectures)

Phase transition of water and its consequences for marine and freshwater life, and rock structures, Clausius–Clapeyron equation of thermodynamics and liquid–vapor phase transition, Soil temperature and heat flow, Aggregation of soil particle size fractions, Stress, strain and strength of soil bodies, Diffusion and dispersion in soils and water. Redistribution, retention and evaporation of soil moisture and gaseous components,

Unit 4: Movement of pollutants in environment (4 lectures)

Diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, mixing heights, hydraulic potential, Darcy's equation, types of flow, turbulence.

Unit 5: Ecophysics (8 lectures)

Soil–Plant–Water Relations, Water entry into soil, Water and energy balance, Plant uptake and water use efficiency; Open or closed ecosystems, Macroscopic flows of matter or energy, Disturbance or catastrophe and phase space changes in ecosystems, Thermodynamic entropy, Ecosystem efficiency, Simulated landscapes.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises (02 Credits: 60 hours)

1. Analyze the variations in hydraulic conductivity of different soil types
2. Determine the soil temperature and thermal conductivity in different soil particle size fractions
3. Find association between heat transfer ability and the soil types
4. Estimate radon released by different materials with time
5. Monitor the health of green plants and variations in photosynthesis with varying fluorescence
6. Interpret the Gaussian plume model for the movement of pollutants in the environment.
7. Analyze the principle and applications of black body radiation and Beer–Lambert law.
8. Simulate the meteorogram of any geographical region and interpret it.

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Learning outcomes:

After this course, students will be able to

- Apply principles of physics to manage soil, water, and plant growth, especially in extreme environment
- Acquire skills to predict and manage pollutant movement across the environmental phases using concepts of physics
- Assess the impact of change in soils properties and field data at the microscale on tracking environmental contaminants
- Analyze soil particle size fractions and determine their impact on the movement of water and other solutes
- Correlate environmental processes in the ocean and terrestrial ecosystems on weather and climate

- Use satellite data to interpret radiation data and its impact on living organisms and ecosystems

Suggested Readings

- Boeker, E. & Grondelle, R. 2011. *Environmental Physics: Sustainable Energy and Climate Change*. Wiley.
- Borghese, F., Denti, P. and Saija, R., 2007. Scattering from Model Nonspherical Particles: Theory and Applications to Environmental Physics. Springer Science & Business Media.
- Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.
- Monteith, J. and Unsworth, M., 2013. Principles of Environmental Physics: Plants, Animals, and the Atmosphere. Academic Press.
- Smith, C., 2004. Environmental Physics. Routledge.

DSC-EVS-3: ENVIRONMENTAL CHEMISTRY

Theory (02 Credits: 30 lectures) + Practicals/Hands-on Exercises (02 Credits: 60 hours)

Course objectives:

- Develop concepts of environmental chemistry as a fundamental principle of various environmental processes
- Link pollutant chemistry as a basis of pollution potential of contaminants
- Gain insights into chemical reactions that govern the movement of chemical contaminants across the environmental compartments and develop solutions that influence pollutant chemistry

Theory (02 Credits: 30 lectures)

Unit 1: Fundamentals of environmental chemistry (7 lectures)

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.

Thermodynamic system; 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, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.

Unit 2: Atmospheric chemistry (4 lectures)

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.

Unit 3: Water chemistry (4 lectures)

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 in water.

Unit 4: Soil chemistry (4 lectures)

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.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises (02 Credits: 60 hours)

1. Prepare buffers/solutions of different molarity and normality using the given stocks solutions
2. Determine the variations in pH of different soils and water samples using various methods.
3. Estimate hardness of given water samples
4. Determine cation exchange capacity of given soils samples
5. Determine the suitability of water for use for agriculture, industrial and domestic purposes based on selected water parameters
6. Estimate contents of selected heavy metals in given water and soil samples and identify their possible sources
7. Analyze variations in air quality index of different regions and correlate with anthropogenic or natural factors
8. Estimate organic matter contents in different soil types
9. Assess soil health based on the concentration of selected macroelements.

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Learning outcomes:

After this course, students will be able to

- Synthesize knowledge on the structure and functions of environmental compartments based on the principles of environmental chemistry
- Acquire analytical and technical skills to recognize and estimate different environmental chemicals

- Apply concepts of environmental chemistry to develop low-cost methods to treat potable and industrial wastewater and manage the quality of water, soil, and air
- Relate and interpret the contaminants exposure and its adverse impacts on living organisms and the health of ecosystems
- Design strategies based on principles of environmental chemistry to influence the environmental fate of contaminants
- Discuss global environmental issues in the background of the chemistry of pollutants

Suggested Readings

- Beard, J.M. 2013. *Environmental Chemistry in Society* (2nd edition). CRC Press.
- Connell, D.W. 2005. *Basic Concepts of Environmental Chemistry* (2nd edition). CRC Press.
- Girard, J. 2013. *Principles of Environmental Chemistry* (3rd edition). Jones & Bartlett.
- Harnung, S.E. & Johnson, M.S. 2012. *Chemistry and the Environment*. Cambridge University Press.
- Hites, R.A. 2012. *Elements of Environmental Chemistry* (2nd edition). Wiley & Sons.
- Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
- Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

GENERAL ELECTIVE 1: ENVIRONMENT AND SOCIETY

Theory (30 Lectures)

Course objective:

- Examine the relationship between the environment and society
- Enable students to understand and appreciate the role played by environment, society, and, their interface in shaping environmental decisions
- Think critically on environmental issues and different solutions

Unit 1: Introduction (3 lectures)

Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic.

Unit 2: Issues in environmentalism (5 lectures)

Significant global environmental issues such as acid rain, climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society.

Unit 3: Development-environment conflict (5 lectures)

Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).

Unit 4: Urbanization and environment (5 lectures)

Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; conflict between economic and environmental interests.

Unit 5: Environment and social inequalities (5 lectures)

Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice; environmental ethics, issues and possible solutions.

Unit 6: Regulatory framework (2 lectures)

Brief account of Forest Conservation Act 1980 1988; Forest Dwellers Act 2008; Land Acquisition Act1894, 2007, 2011, 2012; Land Acquisition Rehabilitation and Resettlement Act 2013.

Unit 7: Community participation (5 lectures)

State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada Bachao Andolan); corporate responsibility movement; appropriate technology movement; environmental groups and movements, citizen groups; role played by NGOs; environmental education and awareness.

Practicals/Hands-on Exercises:

1. Analyze the cultural construction of the environment in a country of your choice
2. Compare and contrast the perception of the environment in countries with varying levels of environmental quality
3. Critically evaluate the developmental status and type of environmental issues across societies from within a country and different countries.
4. Determine the socio-demographic and industrial characteristics of a region and correlate them with the environmental issues of that region?
5. Identify the relationship between societies varying in cultures and environment and analyze the role of economic factors in changing the relationship over time
6. Show any relationship between natural resource use and changing population dynamics of the community
7. Evaluate the pattern of natural resource use by people and their likelihood of participating in the conservation of natural resources
8. Demonstrate any pattern between the resources use and population dynamics, industrial activities, and employment generation in a given region
9. Analyze attitudes, knowledge, and values towards an environmental resource of a population or stakeholder and what trade-off is the public willing to make for conservation of the resource.
10. Determine access to resources across members of a society and suggest measures for equitable sharing of resources or associated benefits, if required.
11. Select an environmental policy/regulation and identify its impact on society over time.

Suggested Readings

1. Cárdenas, J.C., 2009. Experiments in environment and development. Annual Review of Resource Economics, 1(1), pp.157-82.
2. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. *Understanding Environment*. Sagar Publication India Pvt. Ltd., New Delhi.
3. Elliot, D. 2003. *Energy, Society and Environment, Technology for a Sustainable Future*.

Routledge Press.

4. Ioris, A.A.R. ed., 2021. Environment and Development: Challenges, Policies and Practices. Springer Nature.
5. Leopold, A. 1949. *The Land Ethic*. pp. 201-214. Chicago, USA.
6. National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.
7. Stanton, C.Y., 2014. Experiments in Environment and Development. Stanford University.

General Elective 2: HUMAN-WILDLIFE CONFLICT AND MANAGEMENT

Theory (30 Lectures)

Course objectives:

- Analyze causal factors determining conflicts between humans and wildlife
- Gaining insights into complexity of habitat sharing between wildlife and human societies
- Acquire deeper understanding of causal factors of habitat shrinkage and its impact on wildlife dynamics and threats and benefits to human societies
- Reveal the nexus between humans-culture-economy-wildlife
- Develop scientific and social perspective of wildlife conservation.

Unit 1: Introduction to wildlife management (5 lectures)

Need of environmental management; wildlife conservation: moral obligation? philosophy of wildlife management; why is it necessary to worry about human wildlife conflicts? What is the role of government, wildlife biologists and social scientists, concept of deep and shallow ecology.

Unit 2: Evolution of the concept of wildlife management (5 lectures)

Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation laws in India (5 lectures)

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

Unit 4: Socio-economic and legal basis of conflicts (5 lectures)

Concepts of development and encroachment, who is the intruders: human or animal? Impact ofconflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forestdwellers (Recognition of forest right) Act, 2006.

Unit 5: Wildlife conflicts (3 lectures)

Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

Unit 6: Human wildlife coexistence (7 lectures)

Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, case study of Chipko movement, sacred groves forests, India's Bishnoi community and their conservation practices; ecological- economic welfare and development: conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

Practicals/Hands-on Exercises: Based on the theory.

1. Prepare a case study that has potential to develop as a human-wildlife conflicts in the area of your choice.
2. Write a case study describing different aspect of human-wildlife conflict and depict all associated factors in a schematic diagram
3. Using a case study, demonstrate the importance of historical facts in providing solutions in the present day
4. Evaluate merits and demerits of multistage sampling technique while collecting information on human-wildlife conflicts
5. Develop a questionnaire to identify the causal factors of human-wildlife conflicts emerging in a target regions
6. Analyze the roles of psychological factors in development of human-wildlife conflicts
7. Evaluate the relationship between resource scarcity and abundance in determining human-wildlife conflicts
8. Correlate the success and failure in resolving human-wildlife conflicts with existence of institutional framework
9. Use methods of triangulating information, field observations, photography and Problem Animal Control Report as complementary methods to focused interviews to understand the problem and suggest the solution
10. Understanding the significance of mediation among different policies on societal benefits and wildlife conservation to resolve human-wildlife conflicts

Learning outcomes:

After successful completion of this course, students will be able to:

- Develop clear perspective on human-wildlife conflict by defining and examining its historical & present-day status
- Discriminate the underlying factors associated with successful & unsuccessful efforts on providing solutions to human-wildlife conflicts

- Demonstrate the relevance of cultural factors in understanding the issues and providing acceptable and practical solutions
- Critically evaluate different case studies for identifying factors that may have major impact in resolving human-wildlife conflicts

Suggested Readings

1. Angelici, F.M. and Rossi, L., 2020. Problematic Wildlife II. Springer International Publishing.
2. Conover, M. 2001. *Resolving Human Wildlife Conflicts*, CRC Press.
3. Conover, M.R. and Conover, D.O., 2022. Human-Wildlife Interactions: From Conflict to Coexistence. CRC Press.
4. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* **13:** 458-466.
5. Hill, C.M., Webber, A.D. and Priston, N.E. eds., 2017. Understanding conflicts about wildlife: A Biosocial Approach (Vol. 9). Berghahn Books.
6. Manfred, M.J., 2008. Who Cares About Wildlife? Social Science Concepts for Exploring Human-wildlife Relationships and Conservation Issues.
7. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation* **45**: 97-102.
8. Nyhus, P.J., 2016. Human–wildlife conflict and coexistence. Annual Review of Environment and Resources, 41, pp.143-171.
9. Warrier, R., Noon, B.R. and Bailey, L.L., 2021. A framework for estimating human-wildlife conflict probabilities conditional on species occupancy. Frontiers in Conservation Science, p.37.
10. Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistence*. Cambridge.

GENERAL ELECTIVE 3: GENDER AND ENVIRONMENT

Theory (30 Lectures)

Preamble: The paper is designed to expose students to the concept of gender in society and its relevance in the environmental context. The principal objective of the course is to enable students to examine environmental issues from a gender-sensitized perspective.

Unit 1: Introduction (2 lectures)

The socially constructed 'gender' concept.

Unit 2: Gender and society (10 lectures)

Gender existence in society; gender: matriarchy and patriarchy as means of social exclusion (case studies in an Indian context); gender equity issues in rural and urban settings.

Unit 3: Gender and the environment (14 lectures)

Relevance of the concept in an environmental context; evolution of gender hierarchies in historical and contemporary perspective; gendered division of roles in cultural, social and economic perspective; gender inequalities.

Unit 4: Gender, resources and the environment (12 lectures)

Knowledge about the environment among men and women; differential dependencies on environmental resources; implications of gendered responses to environmental degradation.

Unit 6: Gender and environmental management (12 lectures)

Women's participation in environmental movements and conservation; historical and contemporary case studies; role of women in environmental education, awareness and sustainable development.

Unit 7: Strategies for change (10 lectures)

Need for gender equity; Instruments for change: education, media, action groups, policy and management; equity in resource availability and consumption for a sustainable future.

Practicals/Hands-on Exercise

1. Using a case study, demonstrate the value of a gender-inclusive approach in the success of the environmental protection programme
2. Develop a context and show the importance of women's role in environmental conservation by emphasizing gender gaps in access to (a) power, (b) education, (c) markets, and (d) cultural practices.
3. Analyze the national gender policy or laws restricting or promoting women's participation in resolving environmental issues
4. Critically evaluate the national environmental policies for their gender sensitivity by taking an example of climate change-related policies across the sectors, including agriculture, forestry, and water.
5. Identify the gender gaps in policies related to climate change, energy access, natural resource access, and ecosystem services benefits
6. Determine the gender gaps in livelihood activities depend on ecological resources, such as agriculture, fisheries, and forestry, access to new technologies, and capacity-building in STEM (science, technology, engineering, or mathematics) for resolving environmental issues
7. Examine the impact of environmental awareness programmes involving or targeting women, especially to reduce vulnerability to climate change, access to renewable energy, sill development in energy entrepreneurship
8. Find out the variations in perspectives of women and men on environmental security across the societies within and outside country
9. Focused survey in neighbourhood community to gain insights into perception and solution to same environmental issues locally, nationally, and globally
10. Develop an action plan to address an environmental issue selected in practical 9 by incorporating livelihood strategies and economic and decision-making empowerment for women
11. Collect sex-disaggregated data and analyze the success of different environmental conservation programme based on the role of gender while focusing on involvement in decision making, participation in the action plan, the target of information dissemination, avenues of communication, major beneficiaries, and marginalized groups.

Learning outcomes

After the curse, students will be able to:

- Identify causal factors of making woken more vulnerable to environmental calamities and issues
- Reveal the reality of gender inequalities across the countries, challenging the development of risk-resilient individuals and communities
- Demonstrate significant contributions of women as stakeholders while decisions making, educating, and evolving action plans across sectors to provide long-term solutions to environmental problems.
- Show the women's role as a leader in transitioning toward equitable and sustainable societies and industries

Suggested Readings

1. Agarwal, B. 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development* **29:** 1623-1648.
2. Agarwal, B., 2019. The gender and environment debate: Lessons from India. In Population and environment (pp. 87-124). Routledge.
3. Buckingham, S., 2005. *Gender and Environment*. Routledge.
4. Gaarder, E., 2011. Women and the animal rights movement. In *Women and the Animal Rights Movement*. Rutgers University Press.
5. Jackson, C. 1993. Doing what comes naturally? Women and environment in development. *World Development* **21:** 1947-63.
6. Leach, M. 2007. Earth Mother myths and other ecofeminist fables: How a strategic notion rose and fell. *Development and Change* **38:** 67-85.
7. MacGregor, S. ed., 2017. *Routledge Handbook of Gender and Environment*. Taylor & Francis.
8. Miller, B. 1993. *Sex and Gender Hierarchies*. Cambridge University Press
9. Oswald Spring, Ú., 2008. Gender and disasters: human, gender and environmental security. UNU-EHS.
10. Rodríguez-Labajos, B. and Ray, I., 2021. Six avenues for engendering creative environmentalism. Global Environmental Change, 68, p.102269.
11. Stein, R. (ed.). 2004. *New Perspectives on Environmental Justice: Gender, Sexuality, and Activism*. Rutgers University Press.
12. Stephens, A., Lewis, E.D. and Reddy, S., 2018. Towards an inclusive systemic evaluation for the SDGs: Gender equality, environments and marginalized voices (GEMs). Evaluation, 24(2), pp.220-236.

GENERAL ELECTIVE 4: GREEN TECHNOLOGIES

Theory (30 lectures)

Course objectives:

- Gain insights into interdisciplinary aspects of green systems and the environment, and sustainability
- Develop a new perspective on product life cycles for improving efficiency and promoting environmental conservation
- Understand product formulation, process complexity, and infrastructure design to promote sustainability
- Integrate technical and scientific skills for environmental security and industrial sustainability for nation's development

Unit 1: Green technologies (5 lectures)

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport; 3 R's of green technology: recycle, renew and reduce; paradigm shift from 'cradle to cradle' to 'cradle to grave'

Unit 3: Green infrastructure, planning and economy (7 lectures)

Green buildings; history of green buildings, need and relevance, construction, costs and benefits; LEED certified building; Eco-mark certification: importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts. ; Introduction to UNEP's green economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking.

Unit 4: Applications of green technologies (6 lectures)

Increase in energy efficiency: Energy efficient fume hoods, motion detection lighting, or programmable thermostats. Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse). Pollution reduction and removal: Physico-chemical and biological methods

Unit 5: Green chemistry (5 lectures)

Introduction to green chemistry; principles and recognition of green criteria in chemistry; bio-

degradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; photodegradable plastic bags.

Unit 6: Green future (7 lectures)

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

Practicals/Hands-on Exercise

1. Analyze practices of an industry of your choice from India and outside country that has adopted green technology for brand image and economic edge
2. Identify, explain and discuss the ecological principles adopted by the industry selected in practical 1 and analyze their importance
3. Select an industry of your choice where cleaner production is required to improve quality of life and weight its economic, social, and environmental costs
4. Recommend clean development mechanisms and methods of converting waste into wealth in an industry that plays a significant role in your native area or the nation's GDP.
5. Develop a plan for carbon credit and carbon trading where it is not prevalent so far and compare it with a similar plan from a developing or developed country
6. Conduct a Life Cycle Assessment and its elements of a product widely used in your family or residential complex and recommend methods/processes that can help achieve a green tag.
7. Compare and contrast the use of conventional and non-conventional energy sources in your state or country and devise a method for transitioning completely to complete green energy
8. Assess the types and quantity of biomass used as an energy source in your country and evolve a plan to switch towards greener methods in the next 5 years
9. Develop a feasibility status of developing and integrating solar, wind, tidal, and geothermal energy in your nation
10. Evolve an action plan for water recycling for your residential complex by considering the quantity available, type of usage, and existing infrastructure
11. Analyze a case study of commercial green building in your state and discuss the ecological principle(s) adopted for this purpose

Learning Outcomes:

After the course, the students will be able to;

- Apply principles of green chemistry for environmentally safe products
- Design processes that rely on using environmentally benign chemicals and developing economically viable products
- Minimize environmental hazards by improved design for developing industrial products
- Using biotechnology to improve industrial methods and chemical processes as less or non-hazardous, green, safe, and economically acceptable.

- Implement a combination of technical and scientific skills to understand environmental problems better, use resources, manage waste, and develop green infrastructure

Suggested Readings

1. Allen, D.T., 2012. Sustainable Engineering: Concepts, Design, and Case Studies. Pearson
2. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford University Press.
3. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications.
4. Baker, S. 2006. Sustainable Development. Routledge Press.
5. Floyd. A., 2011. Green Building: A Professional's Guide to Concepts, Codes and Innovation. Delmar Cengage Learning
6. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. Green technologies for a more sustainable agriculture (No. 33721). United States Department of Agriculture, Economic Research Service.
7. Striebig, B., Ogundipe, A.A. and Papadakis, M., 2015. Engineering applications in sustainable design and development. Cengage Learning.
8. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.
9. Vallero, D.A. and Brasier, C., 2008. Sustainable Design: The Science of Sustainability and Green Engineering. John Wiley & Sons.
10. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press.