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

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* (5^{th} 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* (2^{nd} edition). CRC Press.
- Connell, D.W. 2005. *Basic Concepts of Environmental Chemistry* (2^{nd} edition). CRC Press.
- Girard, J. 2013. *Principles of Environmental Chemistry* (3^{rd} 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* (2^{nd} edition). Wiley & Sons.
- Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
- Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.