HNB Garhwal University
(A Central University)
Srinagar-Garhwal, Uttarakhand
School of Life Sciences

Syllabus
M.Sc. Environmental Sciences
[Effective from Academic Session 2022-23 (Batch 2022-2024)]

SEMESTER I

PAPER CODE	PAPER NAME	CREDITS
SOLS/EVS-C-001	Fundamentals of Environmental Sciences	03
SOLS/EVS- C-002	Man and Environment	03
SOLS/EVS-C-003	Natural Resources and its Management	03
SOLS/EVS-C-004	Environmental Chemistry and Instrumentation	03
SOLS/EVS-C-005	Lab Course –I	03
SOLS/EVS-C-006	Lab Course –II	03
TOTAL	**18 Core Credits**	

SEMESTER II

PAPER CODE	PAPER NAME	CREDITS
SOLS/EVS-C-007	Environmental Monitoring and Pollution Control	03
SOLS/EVS- C-008	Climate Science: Climate Change, Impact, Mitigation and Adaptation	03
SOLS/EVS-C-009	Environmental Microbiology, Biotechnology and Environmental Toxicology	03
SOLS/EVS-C-010	Ecology and Ecosystem services	03
SOLS/EVS-C-011	Lab Course –I	03
SOLS/EVS-C-012	Lab Course –II	03
SOLS/EVS-SS-001	Environment *Vs* Development	03
TOTAL	**18 Core Credits (03 Self Study)**	

SEMESTER III

PAPER CODE	PAPER NAME	CREDITS
SOLS/EVS-C-013	Environmental Economics and Sustainable Development	03
SOLS/EVS- C-014	Biodiversity Conservation and Restoration Ecology	03
SOLS/EVS-C-015	Lab Course –I	03
SOLS/EVS-E-001	Environmental Geosciences and Disaster management	03
SOLS/EVS-E-002	Traditional Ecological knowledge	03
SOLS/EVS-E-003	Remote sensing, GIS and Environmental Modeling	03
SOLS/EVS-E-004	Environmental Toxicology	03
SOLS/EVS-E-005	Lab Course –II	03
SOLS/EVS-SS-002	Research Methodology and Environmental Statistics	03
TOTAL	**09 Core Credits, 09 Elective Credits (03 Self Study)**	

SEMESTER IV

PAPER CODE	PAPER NAME	CREDITS
SOLS/EVS-C-016	Environmental Management: EIA and Environmental Auditing	03
SOLS/EVS- C-017	Environmental Laws, Ethics and Policies	03
SOLS/EVS-C-018	Lab Course –I	03
SOLS/EVS-E-006	Dissertation	06
SOLS/EVS-E-007	Mountain Ecology	03
SOLS/EVS-E-008	Himalayan Wildlife	03
TOTAL	**09 Core Credits 09 Elective Credits**	

Total Credits: 78 (Core = 54, Elective=18, Self study=06)

SEMESTER I

SOLS/EVS-C 001 Fundamentals of Environmental Sciences (03 credits)

Unit I. Environment

1.1 Definition, scope and importance of Environmental Sciences
1.2 Components of environment: atmosphere, hydrosphere, lithosphere and biosphere
1.3 Concept of Biosphere-2, Noosphere and Technosphere
1.4 Various activities under national environment awareness Campaigns (NEAC)

Unit II. Ecosystem

2.1 Structure of an ecosystem
2.2 Major ecosystems: Himalaya, Marine ecosystems, Deserts, Freshwater ecosystems, Forests and Antarctica ecosystem
2.3 Ecosystem Goods and Services
2.3Energy pathways and ecological processes
2.4 Ecosystem productivity (primary and secondary)
2.5 Biogeochemical cycles: Nitrogen, Carbon, Phosphorus, Sulphur, Water and Oxygen
2.6 Food chain, food web and ecological pyramids

Unit III. Population, Community, Ecological Succession

3.1 Characteristics of population
3.2 Population growth
3.3 Concept and characteristics of communities (concept of habitat, niche, keystone species, dominant species, flagship species and ecotones)
3.4 Ecological succession: primary and secondary succession, climax communities and trends in succession
3.5 Ecological adaptations (Air, Hill, Stream water, Desert and Deep sea)

Unit IV. Self Sustenance of Ecosystem

4.1 Homeostasis in natural ecosystems
4.2 Ecosystem stability and resilience
4.3 Biodiversity and ecosystem stability
4.4 Drivers influencing ecosystem stability

Unit V. Environmental Issues and Problems

5.1 Green house effect, Global warming and climate change
5.2 Conflicts on emission of green house gases
5.3 Eutrophication
5.4 Mega dams and its impact on Environment
5.5 International and national water disputes and coastal zone conflicts

SOLS/EVS-C 002 Man and Environment (03 credits)

Unit I. Man and Environment Relationship

1.1 Pre-historic man and Environment
1.2 Hunting and Gathering society and Environment
1.3 Pastoralism and Environment
1.4 Agro-society and Environment
1.5 Industrial society and Environment
1.6 Future Society (Sustainable Society)

Unit II. Fundamentals of Environmental Sociology

2.1 Definition, concepts, issues and scope of Environmental Sociology
2.2 Concept of caste, tribe, clan, society and social structure
2.3 Cultural Resources
2.4 Indigenous/traditional wisdom for Environmental protection

Unit III. Religion, Culture and Environment

3.1 Role of religion, culture, belief and traditions in conserving environment
3.2 Hinduism and The Environment
3.3 Buddhism and The Environment
3.4 Islam and The Environment
3.5 Christianity and The Environment
3.6 Jainism and The Environment
3.7 Sikhism and The Environment

Unit IV. Environmental Ethics and Moral

4.1 Definition and concept of Environmental Ethics
4.2 Resource consumption patterns and need for equitable utilization
4.3 Anthropocentrism, stewardship, biocentrism, ecocentrism, Cosmo centrism
4.4 Conservation ethics, traditional value system in India
4.5 Sacred Landscapes, Sacred grooves and Sacred species

SOLS/EVS-C 003 Natural Resource Management (03 credits)

Unit I. Principles of Natural Resource Management

1.1 Natural resources- concepts, types and their values
1.2 Factors influencing resource availability, distribution and uses
1.3 Process of resource depletion
1.4 Ecosystem services by various natural resources

Unit II. Forest and Wildlife Resources and their Management

2.1 Forest resources: Major Forest types, their characteristics and distribution status of forest cover
2.2 Forest use and over exploitation: Timber extraction, mining, dams and their effects on forest and tribal people
2.3 Forest management practices
2.4 Wildlife resources: Current status, services and threats
2.5 Human-wildlife conflict and its resolution
2.6 Principles and practices of wildlife management: Need for wildlife planning
2.7 Human dimensions in wildlife management: Project Planning, Monitoring and Evaluation.

Unit III. Water Resources and their Management

3.1 Water resources: Historical background, world scenario and current challenges, status of surface and groundwater
3.2 Use and over exploitation of surface and ground waters
3.3 Integrated Water Resource Management (IWRM): Key challenges and issues
3.4 Legal aspects of water resources and management: Water legislations in India, Water Governance, Policies and legal frameworks

Unit IV. Energy Resources and their Management

4.1 Definition, concept and classification of energy resources
4.2 Non-renewable energy resources (Fossil fuels, Nuclear energy, Hydrogen fuel cell)
4.3 Renewable energy resources (Solar energy, Wind energy, Hydropower energy, Tidal energy, Geo-thermal energy)
4.4 Energy Management : Energy Crisis, Energy audit and sustainable use of energy resources

SOLS/EVS-C 004 Environmental Chemistry and Instrumentation (03 credits)

Unit I. Fundamentals of Environmental Chemistry

1.1 Stochiometry
1.2 Laws of Thermodynamics and Gibbs energy
1.3 Chemical potential
1.4 Chemical kinetics and Chemical equilibrium
1.5 Solubility product
1.6 Concentration Units (Normality, Molarity and Molality
1.7 Saturated and unsaturated hydrocarbons
1.8 Radionuclides
1.9 Redox Potential

Unit II. Atmospheric chemistry

2.1 Tropospheric chemistry
2.2 Atmospheric aerosols and gaseous pollutants
2.3 Mixing height/depth, Lapse rates and Gaussian plume model
2.4 Smog and Fog
2.5 Black carbon
2.6 Stratospheric chemistry

Unit III. Water Chemistry

3.1 Physico-chemical properties of water
3.2 Hydrological Cycle
3.3 Sedimentation, Coagulation, flocculation, filtration
3.4 Freshwater chemistry
3.5 Chemistry of marine water and major ions
3.6 Carbonate system

Unit IV. Soil Chemistry

4.1 Inorganic and organic components of soil
4.2 Mechanism of rock weathering
4.3 Soil pH, Nitrogen pathways
4.4 NPK in soil

Unit V. Instrumentation Techniques

5.1 Titrimetry, Gravimetry
5.2 Flame photometry
5.3 Spectrophotometry (UV-VIS, AAS, ICP-MS)
5.4 Chromatography- Paper, TLC, GLC, HPLC
5.5 Electrophoresis

SOLS/EVS-C 005 Lab Course - I **(03 credits)**

- Exercise 1. Analysis of various components (producer, consumer, decomposer) of ecosystems- lake, pond, river, forest, and mountain
- Exercise 2. Calculation of Importance Value Index (IVI) of different plant species in a grassland ecosystem/forest patch
- Exercise 3. Calculation of frequency, density and abundance of different macrozoobenthos dwelling in the riverine/lacustrine ecosystem
- Exercise 4. Determination of soil texture in different terrestrial habitats
- Exercise 5. Monitoring of biological diversity and calculation of Shannon Wiener diversity index in aquatic/ terrestrial habitats
- Exercise 06. To study the various stages of human evolution
- Exercise 07. To study the artifacts of ancient human
- Exercise 08. To study the social structure of communities in nearby area
- Exercise 09. To study the environmental concerns in various religions
- Exercise 10. To study traditional conservational ethics in various Indian communities

SOLS/EVS-C 006 Lab Course - II **(03 credits)**

- Exercise 01. To prepare an inventory of natural resources of any forest ecosystem located in nearby area.
- Exercise 02. To study the characteristics and functions of a watershed.
- Exercise 03. To study principle and working of solar cooker.
- Exercise 04. To study principle and working of water heating system.
- Exercise 05. To study principle and working of water mill (*Gharat)*
- Exercise 06. Determination of dissolved oxygen (Modified Winkler's method), BOD and COD in a given sample of water
- Exercise 07. Determination of Total solid, total dissolved solids (TDS) and total suspended solids in a water sample
- Exercise 08. Determination of alkalinity, acidity and total hardness in a given water samples
- Exercise 09. Determination of chloride in a given water sample
- Exercise 10. Determination of heavy metals in water and soil samples

SEMESTER II

SOLS/EVS-C 007 Environmental Monitoring and Pollution Control (03 credits)

Unit I. Environmental Monitoring

1.1 Concept and objectives of environmental monitoring
1.2 Global environmental monitoring system (GEMS)
1.3 National environmental monitoring programmes
1.4 Bio indicators and biological monitoring

Unit II. Air and Water Pollution

2.2 Major sources of air and water pollution
2.2 Effects of pollutants on human beings, plants and animals
2.3 Control measures and management techniques for air and water pollution
2.4 Sewage and industrial effluent treatment
2.5 National and international standards for ambient air quality and drinking water quality and effluent water quality
2.6 Indoor air pollution (Smoke, Hydrocarbons, Particulate matter, VOCs, Radon, CO, Biological pollutants, Formaldehyde / Pressed wood Products)
2.7 Marine pollution

Unit III. Noise Pollution

3.1 Sources of noise pollution
3.2 Measurement of noise, exposure levels and standards
3.3 Impact of noise on human health
3.4 Noise control and abatement measures

Unit IV. Radioactive and Thermal Pollution

4.1 Radioactive pollution: causes and consequences
4.2 Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima radio-active leakage
4.3 Radioactive waste management
4.4 Thermal pollution: causes and consequences

Unit V. Solid Waste Management

5.1Types and major sources of solid waste
5.2 Waste characteristic: physical, chemical and biological
5.3 Solid waste and environmental problems
5.4 Integrated solid waste management of municipal waste
5.5 E-waste and its management

SOLS/EVS-C-008 Climate Science: Climate Change, Impact, Mitigation and Adaptation

(03 credits)

Unit I. Introduction to Climatology

1.1 Definition, brief history and scope of Climatology

1.2 Meteorological parameters: temperature, pressure, precipitation, humidity, radiation, wind and clouds

1.3 Composition, structure and importance of atmosphere

1.4 Concept of weather , season and Climate

Unit II. Different Climatological process

2.1 Atmospheric heating and cooling, Heat budget and Heat balance, Global temperature circulation

2.2 Planetary wind pattern and General atmospheric circulation

2.3 Atmospheric moisture: Condensation and different types of precipitation

2.4 Atmospheric humidity: Measurement and distribution

2.5 Oceans and international variations in climate (El Nino, ENSO, La Nina)

2.6 Natural and atmospheric extreme events: Tropical cyclone, thunder storms, tornadoes, flood, cloud burst, drought

Unit III. Regional Climatology

3.1 Definition, microclimate and meso-climate scale

3.2 Climate and distribution of vegetation

3.3 Mid-latitude climate

3.4 Polar and high land climate

Unit IV. Applied Climatology or Responses to Climate Change: Adaptation and Mitigation

4.1 Natural and Anthropogenic (man- made) causes of climate change

4.2 Consequences of climate change

4.3 Climate Change: Biodiversity, agriculture and industry

4.4 Climate change and Food security

4.5 Human response to climate

4.6 Adaptation concepts and strategies

4.7 Limiting climate change: Adaptation and Mitigation

UNIT V. Arctic and Polar Affairs

5.1 Introduction, history and importance of polar and arctic regions/zones on earth

5.2 Structure and Specificity of arctic and polar ecosystems

5.3 Vulnerability of arctic ecosystems

5.4 Periglacial and terrestrial habitats in arctic and polar regions

5.5 Arctic and polar species diversity

5.6 Stress, adaptation and survival in arctic and polar regions

5.7 Climate change and environmental degradation in arctic and polar zones

SOLS/EVS-C-009 Microbiology, Biotechnology and Environmental Toxicology (03 Credits)

Unit I. Environmental Microbiology

1.1 Introduction, history and scope of Environmental Microbiology
1.2 Microbial diversity: major groups of microbes in water, air and soil
1.3 Microbes of extreme environment
1.4 Microbial pathogen and their control

Unit II. Microbial Nutrition and ecology

2.1 Mode Microbial nutrition
2.2 Determination of growth
2.3 Microbial interactions
2.4 Chemolithotrophy and humus
2.5 Effects of environmental factors (Light, temperature, moisture, pH) on microorganisms
2.6 Mechanism of chemotaxis
2.7 Biochemical and molecular methods for microbial isolation and identification

Unit III. Environmental Biotechnology

3.1 Concept, history and scope of Environmental Biotechnology
3.2 Bioremediation and bio-augmentation
3.3 Bio-indicators, bio-fuels and biosensors
3.4 Bio-fertilizer technology
3.5 Fermentation technology
3.6 Aquaculture
3.7 Vermiculture technology

Unit IV. Environmental Toxicology

4.1 Definition, concept and scope of Environmental Toxicology
4.2 Xenobiotic components- Dyes and Detergent, Food Additives, Pesticides and Heavy metals
4.3 Biotransformation: Principle, sites, biotransformation enzymes, biotransformation for gaseous toxicants
4.4 Bioaccumulation: Principle, sub-lethal and indirect effects of bioaccumulation
4.5 Bioremediation, Bio-magnification, and Bio-concentration

Unit V. Toxicity assessment, System Toxicity and Risk Assessment

5.1 *In-vivo* and *in-vitro* toxicity assessment
5.2 Acute and chronic toxicity; Acute , sub acute , sub chronic and chronic toxicity test; concept of bioassay, threshold limit value, margin of safety, therapeutic index
5.3 LD50, LC50, EC50, and IC50
5.4 Factors affecting toxicity
5.5 Translocation and mechanism of toxicants (Absorption, distribution and excretion of toxic agents)
5.6 Risk Assessment (Models, Methods and Management)

SOLS/EVS-C-010 Ecology and Ecosystem Services (03 credits)

Unit I. Fundamentals of Freshwater Ecology

1.1 Definition, concept and scope of Freshwater Ecology
1.2 History of Freshwater Ecology
1.3 Goods and services of freshwater ecosystem
1.4 Freshwater: distribution and depletion
1.5 Freshwater ecosystem: Lake, stream, river, wetland (origin, evolution and characteristics)
1.6 Freshwater biota (lake, river, stream and wetland)
1.7 Basic concept of Hyporheic biodiversity and crenobiodiversity
1.8 Drivers of degradation of freshwater ecosystems and their conservation and management

Unit II. Terrestrial Ecology

2.1 Structure, function and distribution of terrestrial ecosystem
2.2 Major terrestrial ecosystem in the world
2.3 Biomes and Biogeographic realms of worlds
2.4 Forest ecology
2.5 Grassland ecology
2.6 Desert ecology
2.7 Goods and services provided by terrestrial ecosystems
2.8 Drivers of degradation of terrestrial ecosystems and their conservation and management

Unit III. Marine Ecology

3.1 Definition, concept, history and scope of marine ecology
3.2 Physico-chemical aspects of estuaries, marine and mangrove ecosystems
3.3 Biotic communities of estuaries, marine and mangrove ecosystems
3.4 Coral Reef: as a specialized oceanic ecosystem
3.5 Drivers of degradation of coastal ecosystems and their conservation and management

Unit IV. Agro-ecosystem and their Management

4.1 Agriculture in India and the World
4.2 Key concepts of Agro-ecosystems
4.3 Functional basis for the sustainable management of Agro-ecosystems
4.4 Management of Agro-ecosystems

SOLS/EVS-C-011 Lab Course – I **(03 credits)**

- Exercise 1. Monitoring of Particulate matter (PM_{10} and $PM_{2.5}$)
- Exercise 2. Determination of Noise levels at different places
- Exercise 3. Case study of effluent treatment plant and sewage treatment plant in any industry
- Exercise 4. Determination of SOx and NOx in ambient air
- Exercise 5. Identification of biological indicators of pollution in terrestrial and aquatic habitat
- Exercise 6. Measurement of dry and wet bulb temperature
- Exercise 7. Recording of wind speed and direction
- Exercise 8. Preparation of wind roses with the given data
- Exercise 9. Recording of diurnal variations in temperature
- Exercise 10. Modeling of impact of global warming on glaciers

SOLS/EVS-C-012 Lab Course – II **(03 credits)**

- Exercise 1.To study the three dimensional structure of a stream/river
- Exercise 2. Collection and identification of periphyton, phytoplankton and macrophytes
- Exercise 3. Collection and identification of zooplankton and macrozoobenthos
- Exercise 4. Determination of total microbial count in water sample
- Exercise 5. Determination of total count (MPN) of coliform in a water sample
- Exercise 6.Quantitative analysis of heavy metals in environmental samples. Lead, Cadmium, Mercury, Chromium and Arsenic in air, water and soil samples
- Exercise 7. Study of risk assessment model through flow chart
- Exercise 8. Assessment and calculation of toxicity (LD50 / LC 50) through dose response relation
- Exercise 9. To study the different economic value and valuation methods for ecosystem services
- Exercise 10. A case study of ecosystem services provided by any ecosystem (forest/lake/river)

SOLS/EVS-SS-001 Environment *versus* Development (03 credits)

Unit I. Growth and Development

1.1 Definition, concept and scope of economic growth and development
1.2 Classical theories of development
1.3 Contemporary models of development and underdevelopment
1.4 Poverty, inequality and development
1.5 Evolution of worldwide awareness about environment and activity of Nations, environment and awareness programs

Unit II. Resource and Development

2.1 Environment and human resources
2.2 Urbanization and informal sector
2.3 Agriculture transformation and rural development
2.4 International aspect of development

Unit III. Environment *versus* Development

3.1 Development dominant phases at global and National levels
3.2 Conflict between environment development
3.3 Environmental Activism
3.4 Resolution of conflict between environment and development
3.5 Sustainable Development: Various dimensions

Unit IV. Controversies Related with Environment and Development

4.1 Industrial revolution and environment
4.2 Hydropower development and environment in the Himalayas
4.3 Impact of road construction and widening on environment and wildlife
4.4 Ganga *Bachao / Nadi Bachoa Andolan*
4.5 Sand mining and environment

SEMESTER III

SOLS/EVS-C013 Environmental Economics and Sustainable Development (03 credits)

Unit I. Fundamentals of Environmental Economics

1.1 Definition, concepts, issues and scope of Environmental Economics
1.2 Concept of the commons, tragedy of commons, externalities (indirect costs), economic goods/ services, supply, demand, intangibles, public goods and bads
1.3 Limitations of Environmental Economics

Unit II. Economic Tools

2.1 Valuing the environment and natural resources
2.2 Ecology and equity
2.3 Natural resource accounting, cost-benefit analysis
2.4 Life cycle assessment (LCA)
2.5 Intellectual property rights (IPR) and environment

Unit III. Sustainable Development

3.1 Principles of Sustainable Development: History and emergence of the concept and definition of Sustainable Development
3.2 Goals of Sustainable Development
3.3 Stake holders of Sustainable development: People, Government, investor, Industry, Judiciary & international organization working for Sustainable development
3.4 From unsustainable to sustainable development

Unit IV. Social Issues and the Environment

4.1 Resettlement and rehabilitation: Problems and concerns
4.2 National Policy for Rehabilitation and resettlement (NPRR 2007)
4.3 Genesis and evolution of environmental movements
4.4 Major environmental movements (Chipko, Appiko, Narmada Bachao Andolan, Tehri dam conflicts and Silent valley movement, Nadi Bachao Andolan, Beej Bachao Andolan)

SOLS/EVS-C-014 Biodiversity Conservation and Restoration Ecology (03 credits)

Unit I. Introduction to Biodiversity

1.1 Concept and values of biodiversity

1.2 Biodiversity and ecosystem services

1.3 Biodiversity at different levels (genetic, species and ecosystem)

1.4 Magnitude and distribution of biodiversity

1.4 Threats to biodiversity and its loss

1.4 Hotspots of biodiversity

Unit II. Biodiversity: Conservation and Management

2.1 Need for biodiversity conservation and management

2.2 Biodiversity and livelihood

2.3 IUCN threatened species categories

2.4 *In -situ* and *Ex-situ* conservation

2.5 International and National conferences and conventions related to biodiversity

2.6 Biodiversity Act, Biodiversity Rules and Regulations

2.7 International organizations involved in biodiversity management: IUCN, UNEP, UNESCO, WWF

Unit III. Restoration Ecology

3.1 Introduction, concept and scope of Restoration Ecology

3.2 History of Restoration Ecology and Future needs

3.2 Elements of ecological restoration

3.3 Restoration of degraded aquatic ecosystems: springs, rivers and wetlands

3.4 Restoration of terrestrial ecosystem: forest and landscape

Unit IV. Management of Restoration Project

4.1 Setting goals

4.2 Planning

4.3 Action plan

4.4 Adaptive management

4.5 Monitoring

4.6 Legal framework and international agreements

4.7 Indian guidelines for sustainable mining management

SOLS/EVS-C-015 Lab Course- I **(03 credits)**

- Exercise 1. To study socio-economic status- Preparing of questionnaire and case studies
- Exercise 2. Inventorization of local NTPFs.
- Exercise 3. Economic evaluation of a forest area/lake/river
- Exercise 4. Cost-benefit analysis of a river valley project
- Exercise 5. Market survey for forest products
- Exercise 6. To study the restoration of limestone mined area, Doon valley
- Exercise 7. To study restoration and management plan for river sand mined area of any river
- Exercise 8. Preparation of an inventory of WCS/IUCN categories of animal and plant species of any National Park/ Sanctuary
- Exercise 9. Preparation of inventory of endangered and extinct species of plants/animals of India
- Exercise 10. Assessment of threats to biodiversity of a given region

SOLS/EVS-E-001 Environmental Geosciences and Disaster Risk Reduction (03 credits)

Unit I. Fundamentals of Environmental Geosciences and Earth System

1.1 Definition, concept and scope of Environmental Geosciences
1.2 Origin and evolution of the Earth; plate tectonics, rocks and their classification
1.3 Relationship among various geospheres
1.4 Energy budget and thermal environment of the Earth

Unit II. Environmental Geochemistry and Land use Planning

2.1 Concept, importance and use of the Earth elements
2.2 Weathering, soil formation, soil profile, soil classification and distribution
2.3 Land use planning: Soil survey, methods of site selection and evaluation

Unit III. Earth's Processes and Geological Hazards

3.1 Catastrophic geological hazards, hazards in Himalayan and coastal areas
3.2 Terrestrial hazards; floods, landslides, cloud burst, earthquakes, volcanism, avalanche and glacier lake outburst
3.3 Coastal hazards; Tsunami, storms in oceans, ice sheets and fluctuation s of sea levels, marine pollution by toxic wastes

Unit IV. Disaster Management

4.1 Introduction and definition of vulnerability, risk, hazard, disaster and catastrophe
4.2 Impact of disaster on economy and society
4.3 Disaster management cycle
4.4 Disaster management and sustainability

Unit V. Disaster Mitigation and Risk Reduction

5.1 Risk and vulnerability assessment
5.2 Disaster preparedness; information, education, awareness and communication
5.3 Disaster mitigation; approaches and strategies
5.4 Disaster response and planning; Search, Rescue and evacuation, damage, community health and casualty management
5.5 Disaster recovery: social and economic aspects of rehabilitation and resettlement
5.6 Prediction and perception of the hazards
5.7 Community based disaster risk reduction strategies

SOLS/EVS-E-002 Traditional Ecological Knowledge (03 credits)

Unit I. Introduction

1.1. Definition, concept, and scope of TEK
1.2. Traditional ecological knowledge as a science
1.3. TEK in different forms (stories, legends, folklore, rituals, folk songs, and dictums)
1.4. Traditional technology of subsistence (artifacts, crafts *etc.*)
1.5. Language and traditional knowledge

Unit II. Cultural, Sacred, Myth, Rituals and Beliefs

2.1. Basic concept of society, culture and religion
2.2. Nature, aims and objectives of comparative religion (caste, community and their culture).
2.3. Basic feature of religion and principal sets of religion
2.4. Myths, rituals and beliefs associated with TEK in Hinduism, Buddhism, Islam and Christainity
2.5. TEK in Indian Himalayan states

Unit III. TEK and Natural Resources Management

3.1. TEK for forest conservation,
3.2. TEK for water harvesting,
3.3. TEK for wildlife case study
3.4. TEK for conservation of biodiversity
3.5. TEK related with medicinal plants
3.6. TEK related with agriculture and cattle rearing
3.7. TEK related with horticulture

Unit IV. Knowledge Transfer: Old Concepts and Barriers

4.1. Old concepts and barriers in transferring indigenous traditional knowledge
4.2. Old myths in transferring traditional knowledge
4.3. God and man
4.4. Ways of prayers, rituals in different communities

Unit V. Documentation and Preservation of TEK

5.1. Need for Documentation and Preservation
5.2. International laws and policy of TEK
5.3. Laws and policy in India for TEK

SOLS/EVS-E-003 Remote Sensing, GIS and Environmental Modeling (03 credits)

Unit I. General Introduction to Remote Sensing

1.1 Definition, concepts and scope of remote sensing
1.2 History of remote sensing
1.3 Electromagnetic radiations (EMR) and electromagnetic spectrum and atmosphere window
1.4 Platforms, sensors and types of scanning systems
1.5 Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites
1.6 Earth's and atmospheric interaction with EMR
1.7 Spectral reflectance of vegetation, soil and water

Unit II. Application of Remote Sensing

2.1 Application of remote sensing in EIA
2.2 Application of remote sensing in groundwater
2.3 Applications of remote sensing in mining
2.4 Application of remote sensing in forest management
2.5 Application of remote sensing in characterization and monitoring of biodiversity
2.6. Application of remote sensing in mapping of wetlands

Unit III Geographic Information System (GIS)

3.1 Introduction and basic principle and scope of GIS
3.2 Application of GIS
3.3 Brief outline of Digital Image Processing

Unit IV: Environmental Modeling

4.1 Definition, concept and role of modeling in Environmental Sciences
4.2 Components of a model
4.3 Models of population (growth and interaction) and pollution dispersal
    a. Lotka Voltera model
    b. Leslie Matrix model
    c. Gaussian Plume model

SOLS/EVS-E-004 Environmental Toxicology (03 credits)

Unit I. Introduction to Environmental Toxicology

1.1 Definition, concept and scope of Environmental Toxicology

1.2 Common environmental toxicants

1.3 Heavy metals: Sources and their effects on life and environment

1.4 Pesticides: Types, uses and harmful effect of pesticides; brief note on biopesticides, persistent organic pesticides.

1.5 Mutagenic and carcinogenic chemicals, polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anesthetic (chloroform, ether, xylocaine) tobacco chewing and smoking

Unit II. Toxicity Assessment

2.1 *In-vivo* and *in-vitro* toxicity assessment

2.2 Accute, subacute , sub chronic and chronic toxicity test

2.3 Skin and eye test, behavioural, neurotoxic, reproductive, mutagenic test, hypersensitivity and allergy.

2.4 LD50, LC_{50}, EC_{50}, and IC_{50}

2.5 Factors affecting toxicity

Unit III. Systemic Toxicity

3.1 Absorption, translocation and excretion Xenobiotics: Membrane permeability and mechanism of chemical transfer, Absorption of xenobiotics, distribution of toxicants, storage depots, translocation of xenobiotics, membrane barriers, excretion of xenobiotics(major detoxifying glands)

3.2 Neuro toxicity, hepatotoxicity, immunotoxicity, cardio-vascular toxicity, respiratory disfunction and hypersensitivity

Unit IV. Biotransformtion, Bioaccumulation and Biomagnification

4.1 Biotransformtion: Principle, sites, biotransformation enzymes, biotransformation for gaseous toxicants

4.2 Bioaccumulation: Principle, sublethal and indirect effects of bioaccumulation

4.3 Biomagnification, bioconcentration

4.4 Bioremediation

Unit V. Environmental Health and Risk Assessment

5.1 Risk assessment

5.2 Risk assessment models

5.3 Risk assessment methods

5.4 Risk management

SOLS/EVS-E-005 Lab Course – II **(03 credits)**

Section A: Environmental Geosciences and Disaster Management

- Exercise 1. To understand the interior of the Earth
- Exercise 2. To understand the process of soil formation
- Exercise 3. To study the soil profile
- Exercise 4. To study the classification and orders of soil
- Exercise 5. To study the various soil types of India

Section B: Traditional Ecological Knowledge

- Exercise 1: To study origin and evolution of Environmental movement
- Exercise 2 Preparation of an inventory of TEK for water conservation
- Exercise 3: Preparation of an inventory of TEK for biodiversity conservation
- Exercise 4: Preparation of an inventory of TEK related to medicinal plants
- Exercise 5. Documentation of traditional technology of subsistence (Artifacts, Crafts, Handlooms etc.)

Section C: Remote Sensing, GIS and Environmental Modeling

- Exercise 1. Basics of Remote Sensing
- Exercise 2. Photo-interpretation of satellite imagery
- Exercise 3. Ground truth estimation of aerial photographs
- Exercise 4. Basic knowledge of GIS
- Exercise 5. Basic knowledge and use of GPS

Section D: Environmental Toxicology

- Exercise 1. Assessment of toxicity on an organism (fish or tadpole) through dose response relation (LC50/LC50)
- Exercise 2. Bioremediation experiment with the help of water hyacinth
- Exercise 3. Assessment of impact of high temperature on organisms (control experiment)
- Exercise 4. Study of risk assessment model through flow chart
- Exercise 5. Case study of biomagnification in any food chain
- Exercise 6. Quantitative analysis of heavy metals in environmental samples. Lead, Cadmium, Mercury, Chromium and Arsenic in air, water and soil samples

SOLS/EVS-SS-002 Research Methodology and Environmental Statistics (03 credits)

Unit I. Introduction of Research Aptitude

1.1 Research: Meaning, Types and Characteristics
1.2 positivism and post positivistic approach to research
1.3 Methods of research
1.4 Qualitative and Quantitative methods

Unit II. Various steps in the Research

2.1 Identification of research problems
2.2 Search of literature
2.3 Experimental design/construction of hypothesis
2.4 Materials and methods
2.5 Field study and collection of samples/questionnaire
2.6 Collection and analysis of data
2.7 Presentation of data in graphic and tabular form
2.8 Use of statistical tools
2.9 Discussion of results/ testing of hypothesis
2.10 Citation of references and bibliography

Unit III. Application of computer in Environmental Research

3.1 Use of different software for analysis of data- SPSS, Excel
3.2 Use of internet and search for literature
3.3 Format and styles of referencing
3.4 writing of thesis and dissertation
3.5 Plagiarism and research ethics

Unit IV. Environmental Statistics

4.1 Measurement of central tendency- Mean, Mode and Median
4.2 Dispersion- Standard deviation, Standard error, Mean deviation and Coefficient of variation
4.3 Moments – measure of Skewness and Kurtosis
4.4 Distributions - Normal, log-normal, Binomial, Poisson
4.5 Simple and multiple correlation and regression coefficient
4.6 Basic laws and concept of probability
4.7 Test of hypothesis and significance.
4.8 t, F, chi square tests
4.9 ANOVA

SEMESTER IV

SOLS/EVS-C-016 Environmental Management: EIA and Environmental Auditing

(03 credits)

Unit I. Environmental Impact Assessment (EIA)

1.1 Concept, scope and objectives of EIA
1.2 Evolution of EIA and developmental projects under EIA
1.3 Protocol for Environmental Impact Statement (EIS)
1.4 EIA guidelines 1994: Notifications of Government of India
1.5 EIA Notification 2006 and subsequent modifications

Unit II. Methods of Impact Analysis

2.1 Procedure of EIA
2.2 Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided)
2.3 Impact prediction on air, water, land, biota, socio-economic environment
2.4 Concept of Cumulative Environmental Impact Assessment (CEIA)

Unit III. Statuary Clearance Procedure and Public Consultation

3.1 Expert Appraisal Committee(EAC)
3.2 Environmental Clearance, Wildlife Clearance and Forest Clearance
3.3 State Expert Appraisal Committee (SEAC) and State EIA Authority (SEIAA)
3.4 Concept, objectives and procedures of Public Consultation

Unit IV. Post-Project Monitoring and Environmental Auditing

4.1 Principles and guidelines of environmental auditing
4.2 General Audit: Methodology and basic structure of environmental auditing
4.3 ISO 14000 series: ISO 9001, 9002

Unit V. Environmental Management and Management Plan

5.1 Concept, objectives and scope of environmental management.
5.2 Guidelines for EMP
5.3 Development of EMP- air, water, groundwater, noise, land and biodiversity
5.4 Rehabilitation and resettlement
5.5 Compensatory Afforestation
5.6 Green belt development

SOLS/EVS-C-017 Environmental Laws, Ethics and Policies (03 credits)

Unit I. National and International Efforts for Environmental Protection

1.1 Brief introduction about the structure of Indian Constitution
1.2 Environmental protection in the Indian Constitution
1.3 Major Environmental issues, challenges and its response at national and international Level
1.4 International and national efforts related to environmental Pollution, Climate change, Green house Gas emission, Ozone layer depletion and biodiversity conservation)

Unit II. National Environmental Laws

2.1 Indian Forest Act 1927; The Forest Conservation Act 1980, and Forest conservation Rules 2003
2.2 Wildlife Protection Act 1972 and its successive amendments
2.3 Biological Diversity Act 2002 and Biological Diversity Rules 2004
2.4 Water (Prevention and Control of Pollution) Act 1974 and Rules 1975 and subsequent amendments
2.5 Air (Prevention and Control of Pollution) Act 1978 and Rules 1982 and successive amendments
2.6 The Environmental (Protection) Act 1986 and its amendment in 1991, The environment (Protection) Rules 1986
2.7 The National Green Tribunal Act 2010
2.8 The Public Liability Insurance Act 1991

Unit III. National Laws related to waste management

3.1 Biomedical Waste Management rules, 2016, as Amended 2019
3.2 Hazardous and other waste (Management & Transboundary movement) Rules, 2016
3.3 Plastic waste management rules 2016, as amended 2021
3.4 Solid waste management rules 2016
3.5 E-waste rules 2016 and E-waste (Management) Amendment Rules, 2018

Unit IV. National Policies

4.1 Forest Policy
4.2 Environmental Policy
4.3 Water Policy

SOLS/EVS-C-018 Lab course I **(03 credits)**

Exercise 1. Presentation of procedure of Environmental Impact Assessment (EIA) through flowchart

Exercise 2. Presentation of procedure of Environmental Clearance through flowchart

Exercise 3. Presentation of procedure of Forest Clearance through flowchart

Exercise 4. Presentation of procedure of Environmental Auditing through flow chart

Exercise 5.Presentation of procedure of Environmental Management Plan (EMP) through flow chart

Exercise 6. Presentation of salient features of Wildlife Protection Act 1972

Exercise 7. Presentation of salient features of Water (Prevention and Control of Pollution) Act 1974

Exercise 8. Presentation of salient features of the Air (Prevention and Control of Pollution) Act 1981

Exercise 9. Presentation of salient features of The Environmental (Protection) Act and Rules 1986

Exercise 10. Presentation of salient features of The Indian Forest Act 1927

SOLS/EVS-E-007 Mountain Ecology **(03 credits)**

Unit I. Introduction

1.1 Definition, importance and scope of Mountain Ecology
1.2 Specificity of mountain ecosystems
1.3 Environmental importance of mountains

Unit II. Mountain Ecosystem

2.1 Structure and its components
2.2 Geological formations of mountains
2.3 Vulnerability of mountain ecosystems
2.4 Environmental degradation in mountains

Unit III. Environmental Hazards in the Mountains

3.1 Landslides, soil erosion and sedimentation
3.2 Cloud bursts
3.3 Flash floods and river blockades
3.4 Avalanches and Glaciers Lake Outburst Floods (GLOF)
3.5 Earthquakes
3.6 Forest fires

Unit IV. Conservation and Management of Natural Resources of Mountains

4.1 Natural resources of mountains (Forest, Water, Wildlife and Minerals)
4.2 Sustainable exploitation of natural resources
4.3 Traditional wisdom for management of natural resources
4.4 National and international efforts for management of mountains

Unit V. Mountains and People

5.1 Indigenous people of mountains
5.2 Livelihood of mountain people
5.3 Migration of mountain people
5.4 Livelihood security of mountain people

SOLS/EVS-E 008 Himalayan Wildlife **(03 credits)**

Unit I. An Introduction to the Himalaya

1.1 Physiography- location, expansion and importance
1.2 Origin and evolution of the Himalaya
1.3 Himalayan Environment
1.4 Natural resources of the Himalaya
1.5 Fragility of the mountain ecosystem

Unit II. Wildlife of the Himalaya

2.1 Unique characteristics and importance of the wildlife
2.2 Himalayan biodiversity
2.3 Endemism
2.4 Depletion of Himalayan wildlife

Unit III. Manifestation of Himalayan Wildlife

3.1 Himalayan wild Mammals
3.2 Himalayan wild Birds
3.3 Himalayan Reptiles and Amphibians
3.4 Himalayan Fish
3.5 Himalayan Butterflies
3.6 Rare and Endangered Himalayan wild flora

Unit IV. Conservation and Management

4.1 Administrative and legislative measures for protection of wildlife
4.2 Protected areas (National parks, sanctuaries, biosphere reserves) in the Himalaya
4.3 Tiger Project, Project Elephant, Project Rhino, Project Snow Leopard
4.4 Man-Wildlife Conflict: agriculture-wildlife conflict
4.5 Wildlife Protection Act 1972 and successive amendments
4.6 Problems in implementation of the Wildlife Protection Act