

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

**Syllabus
M.Sc. Environmental Sciences
(Effective from 2016-17)**

<u>Semester I</u>	Credits
SOLS/EVS-C-001 Fundamentals of Environmental Sciences	03
SOLS/EVS-C-002 Man and Environment	03
SOLS/EVS-C-003 Natural Resource 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
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(18 Core credits)	

<u>Semester II</u>	Credits
SOLS/EVS-C-007 Environmental Monitoring and Pollution Control	03
SOLS/EVS-C-008 Energy Resources and Management	03
SOLS/EVS-C-009 Environmental Microbiology and Environmental Biotechnology	03
SOLS/EVS-C-010 Freshwater Ecology	03
SOLS/EVS-C-011 Lab Course –I	03
SOLS/EVS-C-012 Lab Course –II	03
SOLS/EVS-SS-001 History and Philosophy of Sciences	03
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(18 Core credits + 03 self study)	

<u>Semester III</u>	Credits
SOLS/EVS-C-013 Environmental Economics, Environmental Sociology and Sustainable Development	03
SOLS/EVS-C-014 Remote Sensing, GIS and Environmental Statistics	03
SOLS/EVS-C-015 Lab Course –I	03
SOLS/EVS-E-001 Climatology and Environmental Modeling	03
SOLS/EVS-E-002 Environmental Geosciences and Disaster Management	03
SOLS/EVS-E-003 Biodiversity Conservation and Restoration Ecology	03
SOLS/EVS-E-004 Environmental Toxicology	03
SOLS/EVS-E-005 Lab Course –II	03
SOLS/EVS-SS-002 Environment vs Development	03
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(09 Core credits + 09 Elective credits +03 Self study)	

<u>Semester IV</u>	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
SOLS/EVS-SS-003 Traditional Ecological Knowledge	03
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(09 Core credits + 09 Elective credits +03 Self study)	

Total Credits: 78 (Core: 54; Elective: 18; Self study: 09)

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

Unit II .Ecosystem

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

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, hillstream 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. Meteorology

- 5.1. Meteorological parameters: temperature, pressure, precipitation, humidity, radiation, wind and clouds
- 5.2. First and second laws of Thermodynamics
- 5.3. Heat transferring process and stability
- 5.4. Inversion and mixing heights, wind roses
- 5.5. Concept of weather, seasons and climate

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. Religion, Culture and Environment

- 2.1. Role of religion, culture and traditions in conserving environment
- 2.2. Hinduism and environment
- 2.3. Buddhism and environment
- 2.4. Islam and environment
- 2.5. Christianity and environment
- 2.6. Sacred grooves and sacred landscapes

Unit III. Environmental Issues and Problems: Causes, Concepts and Control

- 3.1. Green house effect, global warming and climate change
- 3.2. Ozone layer depletion
- 3.3. Acid rains
- 3.4. Deforestation in the Himalaya
- 3.5. Desertification
- 3.6. El Nino, ENSO
- 3.7. Eutrophication in lakes
- 3.8. Mega dams and environment (Tehri dam, Narmada dam, Almetti dam)
- 3.9. Various activities under National Environment Awareness Campaigns (NEAC)

Unit IV. Politics of Ecosystems

- 4.1. International and National water disputes
- 4.2. International coastal zone conflicts
- 4.3. Conflicts on emission of green house gases

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

Unit I. Principles of Natural Resource Management

- 1.1. Natural resources- concepts, kinds and their values
- 1.2. Factors influencing resource availability, distribution and uses
- 1.3. Process of resource depletion
- 1.4. Resource management: preservation, conservation and restoration
- 1.5. Ecological principles of natural resource conservation
- 1.6. Ancient ethics for conservation and management of natural resources

Unit II. Forest Resources and their Management

- 2.1. Forest resources: Major forest types, their characteristics, forest vegetation, status, distribution and ecosystem services
- 2.2. Forest use and over exploitation: Timber extraction, mining, dams and their effects on forest and tribal people
- 2.3. Forest management practices including Joint Forest Management (JFM)
- 2.4. National Forest Policy

Unit III. Wildlife Resources and their Management

- 3.1. Wildlife resources: Current status, services and threats
- 3.2. Wildlife-Animal conflict and its resolution
- 3.3. WCS and IUCN categories of wildlife species
- 3.4. Principles and practices of wildlife management: Need for wildlife planning
- 3.5. Management of special habitats; riparian zones, grasslands, *etc.*
- 3.6. Human dimensions in wildlife management: Project Planning, Monitoring and Evaluation.

- 3.7. National Parks, Sanctuaries, Biosphere Reserves for *in-situ* conservation of wildlife
- 3.8. Wildlife Projects: Tiger, Elephant, Rhino, Snow leopard

Unit IV. Water Resources and their Management

- 4.1 Water resources: Historical background, world scenario and current challenges, status of surface and ground water
- 4.2 Use and over exploitation of surface and ground waters
- 4.3 Integrated Water Resource Management (IWRM): Key challenges and issues
- 4.4 Legal aspects of water resources and management: Water legislations in India, Water Governance, Policies and legal frameworks
- 4.5 National/State Water Policy

Unit V. Geo Resources and their Management

- 5.1. Mineral resources: Minerals, their classification, resources and reserves, uses and exploitation of mineral resources.
- 5.2. Environmental impact of extracting, processing and smelting of minerals
- 5.3. Mineral Resources of India
- 5.4. Conservation and Management of geo-resources

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

Unit I. Fundamentals of Environmental Chemistry

- 1.1. Stoichiometry
- 1.2. Gibbs energy
- 1.3. Chemical potential
- 1.4. Acid base equilibria
- 1.5. Solubility product
- 1.6. Concept of Normality, Molarity and Molality
- 1.7. The carbonate system
- 1.8. Saturated and unsaturated hydrocarbons
- 1.9. Radionuclides
- 1.10. Filtration
- 1.11. Redox Potential

Unit II. Chemical Composition of Air

- 2.1. Tropospheric chemistry- Smog and Fog
- 2.2. Stratospheric chemistry
- 2.3. Carbon dioxide emission and Global temperature
- 2.4. Chemistry of gaseous and particulate pollutants
- 2.5. Atmospheric aerosols

Unit III. Water Chemistry

- 3.1. Physico-chemical properties of water
- 3.2. Concepts of DO, BOD, COD, Sedimentation, Coagulation
- 3.3. Chemistry of fresh water
- 3.4. Estuarine process and major ions
- 3.5. Chemistry of marine water

Unit IV. Toxic Chemicals in the Environment (Air and Water)

- 4.1. Xenobiotic components- dyes and detergents, pesticides
- 4.2. Biochemical aspects of Carbonmonoxide, Arsenic, Cadmium and Mercury
- 4.3. Chemistry of food additives

Unit V. Soil Chemistry

- 5.1. Inorganic and organic components of soil
- 5.2. Mechanism of chemical weathering
- 5.3. Soil pH, Nitrogen pathways
- 5.4. NPK in soil

Unit VI Instrumentation Techniques

- 6.1. Instruments for Limnological analysis (pH meter, Turbidity meter, Conductivity meter, DO Analyser)
- 6.2. Colorimetry
- 6.3. Spectrophotometry and Flamephotometry
- 6.4. Atomic absorption and emission spectrophotometry
- 6.5. Chromatography- Paper, TLC, GLC, HPLC
- 6.6. Electrophoresis
- 6.7. Handling of air pollution measuring devices (SO_x , NO_x , CO_2 , PM_{10} , $\text{PM}_{2.5}$)

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 6. Ecological adaptations in extreme environments
 - Morphological adaptations in fish in hill streams developed under fast water current
 - Desert adaptations in animals and plants
 - High altitude adaptations in organisms
 - Deep sea water adaptations in marine organisms
 - Arboreal adaptations in animals
 - Flight adaptation in birds
- Exercise 07. Recording diurnal variations in temperature
- Exercise 08. Measurement of light intensity by the Lux meter
- Exercise 9. Production of artifacts for expansion by hunting and gathering society
- Exercise 10. Term paper on impact of mega dams on environment
- Exercise 11. Term paper on the manifestation of global warming/ climate change in your area
- Exercise 12. Development of food web with the help of various food chains available in your nearby ecosystem (grassland/river/ pond ecosystem)
- Exercise 13. Preparation of an inventory of traditions prevalent in Hinduism/Islam/ Buddhism/ Christianity for protection of environment
- Exercise 14. Preparation of report on any Sacred groove/ landscapes

SOLS/EVS-C006**Lab Course II****(03 credits)**

- Exercise 1: Preparation of inventory of natural resources of your campus
- Exercise 2: Inventorization of natural resources of a nearby water body
- Exercise 3: Inventorization of natural resources of any National Park/Wildlife Sanctuary
- Exercise 4: To study modern methods of conservation (*in-situ* and *ex-situ*) of natural resources by visiting the establishment
- Exercise 5: Inventorization of drivers of depletions of natural resources of nearby ecosystem (grassland/river/ pond /spring)
- Exercise 6: Principle, working and handling of Flame photometer.
- Exercise 7: Principle, working and handling of Spectrophotometer.
- Exercise 8: Principle, working and handling of Atomic Absorption Spectrophotometer (AAS).
- Exercise 9: Principle, working and handling of Turbidity meter.
- Exercise 10: Principle, working and handling of Conductivity meter.
- Exercise 11: Principle, working and handling of pH meter
- Exercise 12: Principle, working and handling of Electrophoresis unit
- Exercise 13: Determination of dissolved oxygen (Modified Winkler's method) in a given sample of water
- Exercise 14: Determination of Chloride contents in a given sample of water
- Exercise 15: Determination of total dissolved solids (TDS) in a water sample
- Exercise 16: Determination of free CO₂ in a given sample of water
- Exercise 17: Estimation of Potassium and Sodium in a given sample of water and soil
- Exercise 18: Determination of alkalinity in water and soil samples
- Exercise 19: Estimation of Calcium in a water sample
- Exercise 20: Estimation of phosphates and nitrates in a water sample

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. Bioindicators and biological monitoring

Unit II. Air Pollution

- 2.1 Sources of air pollution
- 2.2 Methods of monitoring of SO_x, NO_x, CO, PM_{2.5}, PM₁₀
- 2.3 Effects of pollutants on human beings, plants and animals
- 2.4 Ambient air quality standards
- 2.5 Indoor air pollution (smoke, hydrocarbons, particulate matter, radon)
- 2.6 Control of air pollution

Unit III. Water Pollution

- 3.1 Major sources of water pollution
- 3.2 Water quality indices
- 3.3 Water quality standards (National and International)
- 3.4 Water pollution and human health
- 3.5 Heavy metals and their impact on aquatic life
- 3.6 Sewage and wastewater treatment and recycling
- 3.7 Industrial effluent treatment
- 3.8 Marine water pollution

Unit IV. Noise Pollution

- 4.1. Sources of noise pollution
- 4.2. Measurement of noise, exposure levels and standards
- 4.3. Impact of noise on human health
- 4.4. Noise control and abatement measures

Unit V. Radioactive and Thermal Pollution

- 5.1 Radioactive pollution: causes and consequences
- 5.2. Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima radio-active leakage
- 5.3. Radioactive waste management
- 5.4. Thermal pollution: causes and consequences

Unit VI. Solid Waste Management

- 6.1 Types and major sources of solid waste
- 6.2. Solid waste and environmental problems
- 6.3. Integrated solid waste management of municipal waste
- 6.4. Management of industrial waste
- 6.5. E-waste and its management

SOLS/EVS-C008 Energy Resources and Management (03 credits)

Unit I. An Introduction to Energy Resources

- 1.1. Definition, concept and classification of energy resources
- 1.2. History of energy resource and their development
- 1.3. Global energy and its availability
- 1.4. Global energy use in various sectors
- 1.5. Energy use and its implications (atmospheric pollution and climate change)
- 1.6. Energy crisis and its solution: development of renewable resources
- 1.7. Renewable Energy Application Park (REAP) for public awareness

Unit II. Non-Renewable Sources

- 2.1 Fossil fuels: current status and future scenario, limitations, classification, composition, physico-chemical characteristics and energy contents of fossil fuels
- 2.2 Nuclear energy: Status, power generation, energy conversion through fission and fusion, international nuclear energy policies and regulations, nuclear waste disposal
- 2.3 Hydrogen fuel cell: sources of hydrogen, fuel for vehicles, working of hydrogen fuel cell; future of hydrogen as a energy
- 2.4 Earth minerals and ores as an energy source
- 2.5 Future of non-renewable energy resources

Unit III. Renewable Energy Resources

- 3.1. **Solar Energy:** Sun as source of energy, availability of solar energy, photothermal, photovoltaic cell, various methods of using solar energy (solar cooker, solar still, solar street light, solar lantern, solar domestic light, solar grain dryer, solar water pump, solar heating system, solar T.V.)
- 3.2. **Wind Energy:** History, basic principle, structure of wind mill, advantages and limitations; wind potential at global and national level.
- 3.3. **Hydropower:** Basic principle, status and prospects of hydro power, small hydropower system and their benefits and limitations
- 3.4. **Bio-energy:** Concept, status and future prospects, generation and utilization, biogas and biofuels
- 3.5. **Magneto Hydro Dynamic Power (MHD):** Principle, status, performance and limitations
- 3.6. **Geo-thermal Energy:** Potential sites, origin, types, estimation of geothermal power, application of geothermal energy, environmental issues
- 3.7. **Tidal Energy and Ocean Energy:** principle, performance and limitations
- 3.8. Introduction of Hybrid System: Wind-PV system, Wind- Hydel system, *etc.*

Unit IV. Energy Management

- 4.1. Definition and objectives of energy management
- 4.2. Energy Audit: needs, types and methodology
- 4.3. Energy costs: fuel costs, power cost
- 4.4. Fuel and energy substitution of limited energy resources
- 4.5. Sustainable use of energy resources
- 4.6. Clean Development Mechanism (CDM)

**SOLS/EVS-C 009 Environmental Microbiology and
Environmental Biotechnology (03 credits)**

Unit I. Environmental Microbiology

- 1.1. Introduction, history and scope of Environmental Microbiology
- 1.2. Microbial diversity: major groups of microbes
- 1.2. Microbial diversity of soil
- 1.3. Microbial diversity of water
- 1.4. Microbial diversity of air
- 1.5. Microbes of extreme environments
- 1.6. Microbial pathogens and their control

Unit II. Microbial Nutrition

- 2.1. Mode of microbial nutrition
- 2.2. Determination of growth
- 2.3. Microbial interactions
- 2.4. Chemolithotrophy and humus

Unit III. Microbial Ecology

- 3.1. Effects of environmental factors (Light, temperature, moisture, pH) on microorganisms
- 3.2. Mechanism of chemotaxis
- 3.3. Biochemical and molecular methods for microbial isolation and identification

Unit IV. Environmental Biotechnology

- 4.1. Concept, history and scope of Environmental Biotechnology
- 4.2. Bioremediation and bio-augmentation
- 4.3. Microbial degradation of environmental pollutants (detergents, pesticides, plastics)
- 4.4. Vermiculture technology

4.5. Fermentation technology

4.6. Bio-fertilizer technology

4.7. Aquaculture improvement through biotechnology

SOLS/EVS-C 010 Freshwater Ecology (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 Freshwater: distribution and depletion
- 1.4 Goods and services of freshwater ecosystem
- 1.5 Paleolimnology and climate change

Unit II Stream Ecology

- 2.1 Definition, concept and scope of Stream Ecology
- 2.2 Origin and evolution of streams/ rivers
- 2.3 Stream structure and zonation
- 2.4 Stream hydrology and channel structure
- 2.5 Physical environment, water movement and chemistry
- 2.6 Energy sources and nutrient cycle
- 2.7 Stream biota (Periphyton, plankton, macrophytes, zoobenthos fish, fish otter, dolphin and other aquatic chordates) and evolution
- 2.8 Stream food webs
- 2.9 Basic concepts of Hyporheic biodiversity and crenobiodiversity
- 2.10 Stream Productivity (primary productivity and secondary productivity)
- 2.11 Recent advance in stream ecology(River Continuum Concept; Nutrient Spiraling Concept; Flood Pulse Concept; Hyporheic dynamics; Serial Discontinuity Concept)

Unit III Wetland Ecology

- 3.1 Definition, concept, history and scope of Wetland Ecology
- 3.2 Classification of wetland
- 3.3 The origin and evolution of wetlands
- 3.4 Morphometry, bathymetry and physiography of wetlands
- 3.5 Wetland: Structure and function
- 3.6 Hydrology, chemistry and the physical environment

- 3.7 Stratification of lakes : Temperature and chemical; and their influence on mixing regimes
- 3.8 Energy sources and nutrient cycles in wetland
- 3.9 Primary producers (phytoplankton, macrophytes) measurement indices and factor influencing
- 3.10 Secondary producers (zooplankton, zoobenthos and nekton)
- 3.11 Ecology of reservoirs
- 3.12 Wetland and migratory birds

Unit IV Drivers for Degradation of Streams and Wetlands

- 4.1 Natural drivers (flash floods, landslides, soil erosion, sedimentation, cloud burst, earthquake)
- 4.2 Anthropogenic drivers(Eutrophication, deforestation, agriculture and horticulture practices in catchment area, road constructions and other developmental projects)
- 4.3 Controversies of Hydropower development and Rivers

Unit V Conservation and Management of Streams and Wetlands

- 5.1 Natural and international initiatives
- 5.2 Riparian Area Developmental Plan
- 5.3 Ancient man and stewardship of streams and wetlands
- 5.4 Sacred water bodies
- 5.5 National efforts for conservation of wetlands and streams
- 5.6 Wetland (Conservation & Mangement) Rules 2010
- 5.7 National initiatives (GAP, YAP, *Namami Gange*)
- 5.8 International initiatives (Ramsar convection, *etc*)

SOLS/EVS-C011 Lab course –I (03 credits)

- Exercise 1: Principle and working of solar cooker
- Exercise 2: Principle and working of solar lantern
- Exercise 3: Principle and working of solar street light
- Exercise 4: Principle and working of water heating system
- Exercise 5: Principle and working of water mill (*Gharat*)
- Exercise 6: To demonstrate the I-V and P-V characteristics of PV module with varying radiations and temperature levels
- Exercise 7: To demonstrate the effect of variations in tilt angle on PV module power
- Exercise 8: To demonstrate the effect of shading on module output power
- Exercise 9: To calculate carbon reduction by using solar module
- Exercise 10 Monitoring of PM₁₀ and PM_{2.5}
- Exercise 11: Determination of noise levels at different places
- Exercise 12: Determination of CO₂ emission at different places
- Exercise 13: Determination of SO_x and NO_x in ambient air
- Exercise 14: Identification of biological indicators of pollution in terrestrial and aquatic habitats

SOLS/EVS-C012 Lab course -II (03 credits)

- Exercise 01. To study the three dimensional structure of a stream/river
- Exercise 02. To study the biotopes of riffles, rapids and pools in a hill stream
- Exercise 03. To study the structure and function of hyporheic biotope (self purification zone) of any stream or river
- Exercise 04. To study the structure and function of freshwater springs
- Exercise 05. To study morphometry of any lake
- Exercise 06. Collection and identification of periphyton, phytoplankton and macrophytes
- Exercise 07. Determination of primary productivity in freshwater habitats
- Exercise 08. Collection of zooplankton and macro-zoobenthos
- Exercise 09. To study the characteristics of a nearby watershed
- Exercise 10. Assessment of the health of the freshwater ecosystem by P/R ratio estimation
- Exercise 11. Assessment of nutrient enrichment of a lake (oligotrophic, mesotrophic, eutrophic, dystrophic)
- Exercise 12. Sampling and enumeration techniques for microbes
- Exercise 13. Determination of total microbial count in a water sample
- Exercise 14. Determination of total count (MPN) of coliform in a water sample
- Exercise 15. To prepare the Nutrient Agar medium for culturing bacteria present in our surroundings
- Exercise 16. Isolation of bacteria by the Pour- plate method
- Exercise 17. Isolation of bacteria by the Spread - plate method
- Exercise 18. Isolation of bacteria by the Streak- plate method
- Exercise 19. To prepare the differential medium (MacConky) so as to grow the enteric bacteria
- Exercise 20. Isolation of fungi from the given sample of water
- Exercise 21. Isolation of the *Lactobacillus* bacteria from the given sample of curd.
- Exercise 22. Working principle molecular technique–PCR

SOLS/EVS-SS-001: History and Philosophy of Science
(03 credits)

Unit 1: Introduction to History of Science

- 1.1. What is Science?
- 1.2. A brief history of Science
- 1.3. Origin of Science in ancient times (Mesopotamia, Indus Valley Civilization)
- 1.4. Science in the middle ages
- 1.5. Science and technology in ancient India (Mathematics, Astronomy, Medicine, Metallurgy)
- 1.6. Origin and evolution of Environmental Sciences

Unit 2: Indian Scientific Heritage

- 2.1. Invention of zero
- 2.2. Value of π
- 2.3. Pythagoras theorem of Bodhayana
- 2.4. Revolution of Earth and Sun
- 2.5. Law of Gravity of Bhashkaracharya
- 2.6. Indian scholars and their contributions to Science: *Charak, Susruta, Aryabhata, Varahmihira, Kanād, Parashar, Nagarjun*

Unit 3: Philosophy of Science

- 3.1. What is philosophy of science?
- 3.2. Ancient Indian, Greek, European and American philosophers and their contribution to science
- 3.3. Scientific Revolutions
- 3.4. Religion *versus* Science
- 3.5. Myths and Pseudoscience
- 3.6. Laws of Nature
- 3.7. Discovery *versus* Confirmation

Unit 4: Modern Science

- 4.1. Renaissance and Age of Enlightenment (Kepler, Copernicus, Galileo, *etc.*)
- 4.2. Biology, abiogenesis and evolution (Lamarck, Darwin, Mendel, Crick/Watson)
- 4.3. Classical Physics, including theory of relativity (Newton, Leibniz, Maxwell, Einstein)
- 4.4. New Physics (Thermodynamics, Quantum Physics & String theory: Boltzman, Planck, Schrödinger)
- 4.5. Emerging areas of Modern Science

SEMESTER III

SOLS/EVS-C013 Environmental Economics and Environmental Sociology (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. Fundamentals of Environmental Sociology

- 3.1. Definition, concepts, issues and scope of Environmental Sociology
- 3.2. Concept of caste, tribe, clan, society and social structure
- 3.3. Cultural resources
- 3.4. Indigenous/traditional wisdom for environmental protection

Unit IV. Social Issues and the Environment

- 4.1. From unsustainable to sustainable development
- 4.2. Resettlement and Rehabilitation: Problems and concerns
- 4.3. National Land Acquisition, Rehabilitation and Resettlement Act, 2013
- 4.4. Genesis and evolution of environmental movements
- 4.5. Major environmental movements (Bishnoi movement, Chipko, Appiko, Narmada Bachao, Tehri dam conflict, Silent Valley Movement, *Nadi Bachao, Beej Bachao, Jungle Bachao, Gaon Bachao*)
- 4.6. Rehabilitation of people of disaster affected areas

**SOLS/EVS-C-014 Remote Sensing, GIS and Environmental
Statistics (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
- 3.3 Application of GIS
- 3.2 Brief outline of Digital Image Processing.

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 Simple and multiple correlation and regression coefficient
- 4.4 Basic laws and concept of probability
- 4.5 Test of hypothesis and significance.
- 4.6 t, F, chi square tests
- 4.7 ANOVA

SOLS/EVS-C-015 Lab course I

(03 credits)

Exercise 1. Study of various stages of human evolution

Exercise 2. Socio-economic status of an area- Preparing of questionnaire and case studies

Exercise 3. Analysis and interpretation of questionnaire

Exercise 4. Preparation of inventory of natural resources and intangibles of a forest area/lake/pond/river

Exercise 5. Economic valuation of a forest/lake/river/spring ecosystem

Exercise 6. Cost-benefit analysis of a river valley project

Exercise 7. Documentation of TEK in any tribal area

Exercise 8. Calculation of mean, mode and median of the given data

Exercise 9. Calculation of standard deviation and standard error for given data

Exercise 10. Application of t-test

Exercise 11. Application of chi square test

Exercise 12. Calculation of Pearson's correlation coefficient of relationship between the given environmental data

Exercise 13. Plotting of a regression line between the given environmental variables

Exercise 14. Familiarity with ANOVA

Exercise 15. Photo-interpretation of satellite imagery

Exercise 16. Ground truth estimation of aerial photographs

Exercise 17. Basic knowledge of GIS

Exercise 18. Basic knowledge and use of GPS

SOLS/EVS-E-001 Climatology and Environmental Modelling
(03 credits)

UNIT I: Introduction to Climatology

- 1.1 Definition, brief history and scope of Climatology
- 1.2 Atmospheric variables
- 1.3 Standard atmosphere
- 1.4 Vertical structure of the Earth's atmosphere

UNIT II: Physical and Dynamic Climatology

- 2.1. The energy balance: Nature of radiation, solar source, solar radiation and planetary energy budget
- 2.2. Atmospheric temperature: Seasons, weather, daily temperature changes, vertical distribution of temperature, factor influencing horizontal distribution of temperature
- 2.3. Moisture in atmosphere: Hydrological cycle, relative humidity, evaporation, transpiration, condensation, fog, clouds and precipitation
- 2.4. Motion in the atmosphere: Atmospheric pressure, wind, Coriolis effect
- 2.5. Global circulation of the atmosphere
- 2.6. Oceans and international variations in climate (El Nino, ENSO, La Nina)
- 2.7. 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

- 4.1. Human response to climate
- 4.2. Climate, agriculture and industry
- 4.3. Global changes and atmospheric chemistry: Acid precipitation, Ozone depletion
- 4.4. Natural causes of climate change
- 4.5. Warming of the planet Earth and its consequences

UNIT V: Environmental Modelling

- 5.1. Definition, concept and role of modelling in Environmental Sciences
- 5.2. Components of a model
- 5.3. Models of population (growth and interaction) and pollution dispersal
 - a. Lotka Volterra model
 - b. Leslie Matrix model
 - c. Gaussian Plume model

**SOLS/EVS-E-002 Environmental Geosciences and Disaster
Management (03 credits)**

Unit I. Fundamentals of Environmental Geosciences and Earth System

- 1.1. Definition, concept and scope of Environmental Geosciences
- 1.2. Origin and geological evolution of Earth
- 1.3. Formation and structure of the Earth; plate tectonics, rocks and their classification
- 1.4. Brief account of relationship among various geospheres- lithosphere, hydrosphere and biosphere
- 1.5. Energy budget of the Earth, Earth's thermal environment and seasons

Unit II. Earth's Processes and Geological Hazards

- 2.1. Earth's processes: Concept of residence time and rates of natural cycles
- 2.2. Catastrophic geological hazards
- 2.3. Study of floods, landslides, earthquakes, volcanism and avalanche
- 2.4. Tsunami, ice sheets and fluctuations of sea levels, marine pollution by toxic wastes
- 2.5. Prediction and perception of the hazards and adjustments to hazardous activities

Unit III. Environmental Geochemistry and Land use Planning

- 3.1. Concept of major, trace and REE (Rare Earth Elements)
- 3.2. Classification of trace elements, mobility of trace elements
- 3.3. Human use, trace elements and health, possible effects of some trace elements
- 3.4. Weathering and soil formation, soil profile, soil classification, soils of India
- 3.5. Land use planning: Soil surveys in relation to land use planning, methods of site selection and evaluation

Unit IV: Fundamentals of Disaster and Disaster Management

- 4.1. Definition, types of disaster and need for disaster management
- 4.2. Natural disasters: Hydrological, wind related, geophysical and climate related
- 4.3. Man-made disasters: Nuclear disaster, industrial, Environmental (forest fire), rail, road, air and sea accidents
- 4.4. Disaster preparedness (concept, nature, plan and mitigation)
- 4.5. Disaster response (Plan, communication, logistic management, stress and panic movement, integration of multiple stakeholders)
- 4.6. Disaster medicine (Prevention, preparedness, response and recovery of health problems)
- 4.7. Post disaster management (Relief camps, role of voluntary organizations and armed forces)

Unit V: Rehabilitation, Reconstruction and Recovery

- 5.1. Reconstruction and rehabilitation as a means of development
- 5.2. Damage assessment
- 5.3. Role of various agencies in disaster management
- 5.4. Development of physical and economic infrastructure
- 5.5. Information management structure
- 5.6. Education and awareness
- 5.7. Constrain in monitoring and evaluation
- 5.8. Long term recovery and counter disaster planning

SOLS/EVS-E-003 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, anaesthetic (chloroform, ether, xylocaine) tobacco chewing and smoking

Unit II. Toxicity Assessment

- 2.1 *In-vivo* and *in-vitro* toxicity assessment
- 2.2 Acute , subacute , sub chronic and chronic toxicity test
- 2.3 Skin and eye test, behavioural, neurotoxic, reproductive, mutagenic test, hypersensitivity and allergy.
- 2.4 LD₅₀, LC₅₀, EC₅₀, and IC₅₀
- 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, cardiovascular toxicity, respiratory dysfunction and hypersensitivity

Unit IV. Biotransformation, Bioaccumulation and Biomagnification

- 4.1 Biotransformation: 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-004 Biodiversity Conservation and Restoration
Ecology (03 credits)**

Unit I. Introduction to Biodiversity

- 1.1. Concept and values of biodiversity
- 1.2. Magnitude and distribution of biodiversity
- 1.3. Biodiversity at different levels (genetic, species and ecosystem)
- 1.4. Biodiversity and ecosystem services
- 1.5. Threats to biodiversity and its loss
- 1.6. Hotspots of biodiversity

Unit II. Biodiversity: Conservation and Management

- 2.1. Need for biodiversity conservation and management
- 2.2. Biodiversity and livelihood
- 2.3. WCS and IUCN threatened species categories
- 2.4. *In-situ* and *Ex-situ* conservation
- 2.5. Biodiversity Act, Biodiversity Rules and Regulations
- 2.6. International Biodiversity Law, CBD, Trade related Intellectual Property Rights, CITES, Ramsar Convention
- 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
- 3.3. Elements of ecological restoration
- 3.4. Restoration of degraded aquatic ecosystems: springs, rivers and wetlands.
- 3.5. Restoration of terrestrial ecosystem (forest, landscape, soil)

- 3.6. Restoration of mined areas with special reference to Doon Valley
- 3.7. Ecological restoration of ecosystem damaged by construction and widening of National Highways and roads

Unit IV. Management of Restoration Project

- 4.1. Setting goals
- 4.2. Planning
- 4.3. Action plan
- 4.4. Mined Closure Plan (Major/ minor minerals)
- 4.5. Adaptive management
- 4.6. Monitoring
- 4.7. Legal framework and international agreements
- 4.8. Indian guidelines for sustainable mining management
- 4.9. Case study: Integrated restoration management of severely degraded ecosystem

SOLS/EVS-E-005 Lab course II

(03 credits)

Section A: Climatology and Environmental Modelling

- Exercise 1. Measurement of dry and wet bulb temperature
- Exercise 2. Recording of wind speed and direction
- Exercise 3. Preparation of wind roses with the given data
- Exercise 4. Recording of diurnal variations in temperature
- Exercise 5. Modelling of impact of global warming on glaciers

Section B: Environmental Geosciences and Disaster Management

- Exercise 1. Study of sediments and soil
- Exercise 2. Soil surveys in relation to land use planning
- Exercise 3. Understanding the Earth's interior with the help of a diagram
- Exercise 4. Role of various agencies in Himalayas for disaster management in the Himalaya
- Exercise 5. Inventory of landslide prone areas of Uttarakhand.
- Exercise 6. Assessment of genesis, impact and management of any eco-disaster.
- Exercise 7. Preparation of report on environmental risk assessment of any developmental project

Section C: 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

Section D: Biodiversity Conservation and Restoration Ecology

- Exercise 1. To study the restoration of limestone mined area, Doon valley
- Exercise 2. To study restoration and management plan for river sand mined area of any river
- Exercise 3. Preparation of an inventory of WCS/IUCN categories of animal and plant species of any National Park/Sanctuary
- Exercise 4. Preparation of inventory of endangered and extinct species of plants/animals of India
- Exercise 5. Assessment of threats to biodiversity of a given region

SOLS/EVS-SS-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.*)

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.
- 2.5. Myths, rituals and beliefs associated with TEK in Buddhism
- 2.6. Myths, rituals and beliefs associated with TEK in Islam
- 2.7. Myths, rituals and beliefs associated with TEK in Christianity
- 2.8. 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
- 5.4. Reposition of TEK by CSIR, Govt. of India

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 its development
- 1.3. Developmental projects under EIA
- 1.4. Protocol for environmental impact statement (EIS)
- 1.5. EIA Laws and Policy: An overview
- 1.6. EIA guidelines 1994: Notifications of Government of India
- 1.7. EIA Notification 2006 and subsequent modifications

Unit II: Methods of Impact Analysis

- 2.1. Procedure of EIA
- 2.2. Screening, scoping and baseline data collection for EIA
- 2.3. Impact prediction on air, water, land, biota, socio-economic environment
- 2.4. Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided)
- 2.5. Concept of Cumulative Environmental Impact Assessment (CEIA)
- 2.6. Case studies of EIA: River valley projects, mining, road construction, industries

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. Permission for carrying out survey and investigation

- 3.4. State Expert Appraisal Committee (SEAC) and State EIA Authority (SEIAA)
- 3.5. Concept and objectives of Public Consultation
- 3.6. Techniques and consultation approach for 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. Preparation and submission of audit report to the regulatory bodies
- 4.4. ISO 14000 series: ISO 9001, 9002

Unit V. Environmental Management and Management Plan

- 5.1. Concept, objectives and scope of environmental management.
- 5.2. Environmental management in terms of developmental projects
- 5.3. Guidelines for EMP
- 5.4. Development of EMP- air, water, groundwater, noise, land and biodiversity
- 5.5. Rehabilitation and resettlement
- 5.6. Compensatory afforestation
- 5.7. Green belt development
- 5.8. EMP of any development project (case study)

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

Unit I. National and International Efforts for Environmental Protection

- 1.1. Provision of environmental issues and problems in National and International Agenda
- 1.2. Environmental protection in the Indian Constitution (Article 48A, Article 51A (g))
- 1.3. International efforts (Stockholm Conference, Montreal Protocol, Kyoto Protocol and other climate related agreements, Ramsar Convention, CITES)

Unit II. National Environmental Laws-1

- 2.1 Indian Forest Act 1927; The Forest Conservation Act 1980 and Rules 1981 and successive amendments
- 2.2 Wildlife Protection Act 1972 and subsequent amendments
- 2.3 Water (Prevention and Control of Pollution) Act 1974 and Rules 1975 and subsequent amendments
- 2.4 Air (Prevention and Control of Pollution) Act 1978 and Rules 1982 and successive amendments
- 2.5 The Environmental (Protection) Act 1986 and Rules 1986 and successive amendments

Unit III. National Laws –II

- 3.1 National Environmental Tribunal Act 1995; National Green Tribunal (NGT)
- 3.2 Public Liability Insurance Act 1991
- 3.3 Biomedical Waste (Management and Handling) Rules 1998 and successive amendments
- 3.4 Hazardous Waste (Management and Handling) Rules 1989
- 3.5 Biological Diversity Act 2002 and Rules 2004, and successive amendments

Unit –IV. National Policies and Ethics

- 4.1. Forest Policy
- 4.2. Environmental Policy
- 4.3. Water Policy
- 4.4 Definition and concept of environmental ethics
- 4.5 Resource consumption patterns and need for equitable utilization
- 4.6 Anthropocentrism, stewardship, biocentrism, ecocentrism, cosmocentrism,
- 4.7 Conservation ethics, traditional value system in India

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

- Exercise 1. Presentation of EIA through flowchart
- Exercise 2. Presentation of case study of EIA of any developmental project
- Exercise 3. Presentation of procedure of environmental auditing through flow chart
- Exercise 4. To prepare an audit report for submission to the regulatory body
- Exercise 5. Presentation of environmental clearance (EC) through flow chart
- Exercise 6. Presentation of forest clearance (FC) through flow chart
- Exercise 7. Presentation of wildlife clearance (WC) through flow chart
- Exercise 8. Presentation of salient features of Wildlife Protection Act 1972
- Exercise 9. Presentation of salient features of Water (Prevention and Control of Pollution) Act 1974
- Exercise 10. Presentation of salient features of the Air (Prevention and Control of Pollution) Act 1981
- Exercise 11. Presentation of salient features of The Environmental (Protection) Act and Rules 1986
- Exercise 12. 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

SOLS/EVS-SS-003 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 Bachao Andolan*
- 4.5 Sand mining and environment