

UNIVERSITY OF LADAKH



SYLLABUS OF M.Sc ENVIRONMENTAL SCIENCE

DEPARTMENT OF ENVIRONMENTAL SCIENCE

UNIVERSITY OF LADAKH

INTRODUCTION

Programme Specific Objectives

The Master's course in Environmental Science was aim to train students with the objective of teaching-learning and research to promote the idea of sustainability. This objective shall be achieved through developing a foundation on ecological, social, economic, legal and ethical dimensions of the environmental studies on a robust interdisciplinary foundation.

Programme Outcomes

After completion of the Master's degree, the students would be empowered with multi- disciplinary tools to:

- Transform into original researchers and undertake cutting-edge research and teaching for an in- depth understanding of the complex environmental issues.
- Predict the environmental change and provide scientifically sound and socially acceptable solutions.
- Develop as sustainability managers to guide manufacturing industries, non-government organizations (national and international), policy-making bodies.

Course Description: M.Sc. Post Graduate Program in Environmental Science is of two-year duration, spread over four semesters and comprising of 23 courses of 92 credits (20 courses of 4 credit, 2 courses of 2 credits and 1 course of 8 credits). The 20 courses are grouped into three categories – Core (11 courses of 44 credits, all of which are compulsory), Elective (3 courses of 12 credits, to be selected out of 6 elective courses), Generic (2 courses of 2 credits compulsory), Practical (6 courses of 24 credits, all compulsory) and Dissertation/project work (8 credits).

It is mandatory for each student to complete a Dissertation/project that will be assigned during 4th semester and will be assessed on the basis of Presentation, Viva and thesis submission.

Post Graduate Attributes of the Programme

- The core courses cover central and vital areas of environmental science, about which all students should have knowledge.
- The elective courses cover contemporary, specialized and super-specialized areas.
- The **generic courses** cover general environmental science area for all disciplines.
- All the post-graduate courses are at advanced level, and have been constructed as continuity over the under-graduate courses, which are seen as basic, and are taught at foundation level. The present structure thus covers the foundational aspects of the discipline, and also builds towards specialization.

INTRODUCTION TO CBCS (CHOICE BASED CREDIT SYSTEM)

SCOPE

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core and elective courses. The courses are evaluated following the grading system, which provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

DEFINITIONS

- a) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.
- b) 'Course' means a segment of a subject that is part of an Academic Programme.
- c) 'Programme Structure' means a list of courses (Core, Elective & Generic) that makes up an Academic Programme, specifying the syllabus, credits, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc, prepared in conformity to University Rules, eligibility criteria for admission.
- d) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree, and which cannot be substituted by any other course.
- e) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.
- f) 'Credit' means the value assigned to a course which indicates the level of instruction.
- g) 'One Credit' equals to one-hour lecture/tutorial/or two-hour practical per week. Credit for a practical may be proposed as part of a course or as a separate practical course.

PROGRAMME STRUCTURE

The Master's programme is a two-year course divided into four-semesters. A student is required to complete 92 credits for the completion of course and the award of degree.

- Duration of examination of each course shall be 3 hours (for Theory courses) and 4 hours (for Practical courses).
- The courses will be of 2, 4, and 8 credits wherein 50% marks shall be allocated for end semester examination, and 50% marks for internal assessment as decided by the university academic council.
- In order to incorporate an element of Continuous Internal Assessment of students, the Departments will conduct the following:
 1. Written Tests
 2. Laboratory Performance Grading
 3. Classroom Presentation
 4. Attendance Marks
 5. Home Assignments

The schedule of papers prescribed for various semesters shall be as given in the next page.

Instructions/Pattern of End Semester Question Paper (Theory Courses)

1. There will be two sections A and B.
2. There will be 9 questions in all.
3. Section A will carry one compulsory question (question no 1) with four sub-parts (consisting of short answer type questions). Each sub-part (short answer type question) will be from each unit and a student will have to attempt all the four sub-parts.
4. Section B will comprise of four long answer type questions (question number 2 to 5); each question will have an option. Thus, there will be two questions from each unit. In total, there will be eight questions in the section; two from each unit and a candidate will be asked to attempt four questions.
5. All short answer type questions will carry 2½ marks each. Thus, question No 1 will carry weightage of 10 marks. Whereas, each question from no 2 to 5 will carry equal marks of 10 marks.

Note: There will be internal examinations (Assignments, Tests and Presentations) of 50% marks in each semester. End-semester examination will be of the rest 50% marks in each semester.

COMPLETE COURSE STRUCTURE

Course Code	Course Title	Course Credits
1st SEMESTER		
PG-EVS-C1.1	Fundamentals of Ecology	4
PG-EVS-C1.2	Basics of Earth Sciences	4
PG-EVS-C1.3	Fresh Water Ecology	4
<i>Elective Course (Any of the following)</i>		
PG-EVS-E1.1	Natural Resources	4
PG-EVS-E1.2	Soil Biology & Fertility	4
PG-EVS-P1.1	Lab Course (as per theory)	4
PG-EVS-P1.2	Field Tour & Study	4
Total Credits		24
2nd SEMESTER		
PG-EVS-C2.1	Environmental Chemistry and Toxicology	4
PG-EVS-C2.2	Environmental Pollution and Disaster Management	4
PG-EVS-C2.3	Meteorology and Global Climate Change	4
<i>Elective Course (Any of the following)</i>		
PG-EVS-E2.1	Solid/Hazardous Waste Management	
PG-EVS-E2.2	Social Perspectives of the Environment	4
PG-EVS-G2.1	Occupational Hazards	2
PG-EVS-P2.1	Lab Course (as per theory)	4
PG-EVS-P2.2	Field Tour & Study	4
Total Credits		26
3rd SEMESTER		
PG-EVS-C3.1	Environment Impact Assessment, Auditing and Environmental Awareness	4
PG-EVS-C3.2	Biodiversity and Its Conservation	4
PG-EVS-C3.3	Environmental Technology, Hygiene And Instrumentation	4
<i>Elective Course (Any of the following)</i>		
PG-EVS-E3.1	Environmental Legislation, Treaties, Population And Sustainability	4
PG-EVS-E3.2	Forest Ecology	4
PG-EVS-G3.1	Environmental Economics	2
PG-EVS-P3.1	Lab Course (as per theory)	4
PG-EVS-P3.2	Field Tour & Study	4
Total Credits		26
4th SEMESTER		
PG-EVS-C4.1	Biostatistics, Research, Restoration & Mountain Ecology	4
PG-EVS-C4.2	Environmental Biotechnology, Organic Farming & Social Issues	4
DISSERTATION/PROJECT WORK		8
Total Credits		16
Grand Total Credits (I, II, III & IV Semester) = 92		

COURSE DETAIL

SEMESTER - I

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – I (Core Course)		
Course Title: Fundamentals of Ecology		Course Code: PG-EVS-C1.1
Credits: 04	Paper - I	Max. Marks: 100

Unit – I: Introduction to Ecology and Environmental Sciences

15 Hours

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and specification. Autecology and Synecology. Ecosystem stability-cybernetics and ecosystem regulation. Evolution of biosphere. General concepts of level of organization,. Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors).

Unit – II: Abiotic & Biotic Components of Ecosystem

15 Hours

Abiotic ecosystem, Environmental factors (temperature, light, water, etc). Biotic community; General characteristics of a community. Food chain and Food web, Disruption & Consequences. Energy flow in eco-systems. Concepts of productivity, Standing crops, ecological indicators, Ecological efficiencies, edge effect. Ecological niche (concept, definition and types of niche, Gause's Principle), character displacement (Allopatry and sympatry), Ecotones; mechanism of ecological succession, concept of climax.

Unit – III: Dynamics of Ecosystems

15 Hours

Structure and functions of ecosystems. Biomes and Bio-geographical realms /ecozones; their concepts and classification. Ecological Pyramids and its types. Nutrient cycling (Carbon, Nitrogen and Phosphorus). Primary and secondary productivity - Definition, measurement of biomass and productivity in terrestrial and aquatic communities. Productivity of terrestrial ecosystem; forest, Desert and grassland ecosystems.

Unit – IV: Population Ecology

15 Hours

Characteristics of population, concept of carrying capacity, population growth and regulations, population fluctuations, dispersion, metapopulation, density, natality, mortality, survivorship curves, age distribution, growth curves and models. Concept of 'r' and 'k' species. Population interaction; mutualism, predation, commensalism, amensalism, parasitism, competition. Inter and intra specific interaction (Positive and negative interaction). Lotka-Volterra model, Concept of camouflage.

Suggested Readings:

1. Ecology - P.D. Sharma
2. Principles of ecology – Rickleff
3. Benton, A.H. and Werner, W.E. (1976).Field Biology and Ecology. Tata Mc. Graw Hill Publishing Company Ltd. New Delhi.
4. Chapman, J.L. and Reiss, M.J. (1995). Ecology-Principles and applications.
5. Claude Fauric; C.Ferra; Medori, P. & Devaux, J. (2001). Ecology. Sciences & Practice. Oxford & IBH Pub. Co. Pvt. Ltd. (N. Delhi).
6. Dash, M.C. (1993).Fundamentals of Ecology. Tata Mc.Graw Hill Publishing Company Ltd. New Delh
7. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
8. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
9. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – I (Core Course)		
Course Title: Basics of Earth Sciences		Course Code: PG-EVS-C1.2
Credits: 04	Paper - II	Max. Marks: 100

Unit - I: Introduction

15 Hours

Soil; definition, mechanism of formation, physical and chemical properties, soil profile, Soil texture, textural classes, mechanical analysis, specific surface. Soil organic carbon, Cation exchange properties, podzolization, laterization, calcification and gleization and salinization, Inorganic and organic components of soil; humus its types and formation, Soil erosion; concept, types and techniques of its control. soil tilth, characteristics of good soil tilth. thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Unit - II: Interior of Earth

15 Hours

Interior of the earth-crust, mantle, and core. Seismic waves, types of seismic waves and their role in the study of Earth's interior. Discontinuities in the interior of the earth. Earthquakes – their causes and measurement. Concepts of stress and strain. Different zones in the Earth's interior and their composition. The Earth's Magnetic Field - Magnetic reversal and magnetic anomaly. Continental Drift Theory, Plate Tectonic and Sea floor Spreading. Theory of isostasy and global isostatic adjustment.

Unit - III: Geomorphological Processes

15 Hours

Development in geomorphology. Historical and process Geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Concept of elements, minerals and rocks. Igneous, sedimentary and metamorphic rocks, Rock cycle, Folds and faults, major types of folds and faults, Physical weathering, chemical weathering and their types, Volcanism - Components and types of volcanoes, volcanic materials, process and effects of volcanism. River forms and processes – stream flow, stage-discharge relationship.

Unit - IV: Geomorphological Systems

15 Hours

Factors affecting landform development. Fluvial system - Factors affecting stream erosion and deposition, erosional and depositional landforms. Underground water system – Underground Water table, landforms formed by ground water action. Aeolian system - Mechanism of wind erosion, erosional and depositional landforms. Glacial system - Mechanism of glacial erosion, erosional and depositional landforms. Exogamic Processes: Concept of gradation, Agents and processes of gradation, causes, types and classification of weathering, mass movement erosion depositional process and resultant landforms.

Suggested Readings:

1. Cooke, R.U. and Doornkamp, J.C. (1974). Geomorphology in Environmental Management An Introduction, Clarendon Press, Oxford, U.K.
2. Easterbrooke, D.J. (1969). Principles of Geomorphology. McGraw Hill, New York.
3. Keller, E.A. (1999). Introduction to Environmental Geology. Prentice Hall, New Jersey.
4. Press, F. and Siever. R. (1994). Understanding Earth. W.H. Freeman & Co., U.S.A.
5. Ritter, D.F.; Kochel, R.C. and Miller, J.R. (1995). Process Geomorphology. Wm. C. Brown Publishers, U.S.A.
6. Singh, S. (2000). Physical Geography. Prayag Pustak Bhawan, Allahabad.
7. Smithson, P.; Addison, K. and Atkinson, K. (2002). Fundamentals of the Physical Environment. Routledge Publishers, London.
8. Strahler, A.H. and Strahler, A.N. (1992). Modern Physical Geography. John Wiley & Sons, New York.
9. Wild, R. (1993). The Earth Care Annual. National Wildlife Federation, Rodale Press, Pennsylvania.
10. <http://www.pbs.org/wnet/savageearth/>
11. <http://www.usgs.gov/network/science/earth/earth.html/>

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – I (Core Course)		
Course Title: Fresh Water Ecology		Course Code: PG-EVS-C1.3
Credits: 04	Paper - III	Max. Marks: 100

Unit – I: Lakes

15 Hours

Lakes: Chemistry of Lakes. Origin and Classification. Stratification: thermal and chemical. Lake Origins & Morphometry. Biological characteristics of lakes: Neuston, plankton, nekton and benthos. Watersheds, Stream Flow & Physical Structure Physical characteristics of Lakes, rivers and springs. Chemical characteristics of Lakes, Rivers and springs. Overview of stream and river ecosystems. Human impacts on streams. Management of Aquatic Systems.

Unit – II: Aquatic Organisms

15 Hours

Phytoplankton – diversity and models of nutrient-limited growth, paradox of plankton. Plankton: importance and management. A general account of zooplankton A general account of benthic and periphytic communities. Biological Communities of Lakes: Littoral, Benthos & Fish. Biological Communities of Streams. Characteristics of running water habitats; river continuum concept. Macrophytes: importance, classification and management.

Unit – III: Wetland Ecosystem and its Management

15 Hours

Wetland ecosystem, classification, importance. Chemistry of Wetlands. Eutrophication: Causes, consequences and control measures. Degradation causes and consequences of wetland. A general account of estuaries. Ramsar convention on wetland; List of wetland of international importance. Biological Communities of Wetlands: Primary Producers. Biological Communities of Wetlands: Consumers. Management of degraded wetlands.

Unit – IV: Ocean Ecosystem

15 Hours

Introduction: history and niche of marine ecology; contrasts to terrestrial ecosystems. Classification of marine environment. Oceans: Physical and chemical properties of seawater, circulation and zonation in ocean. Marine plants - cyanobacteria, chrysophyta, dinophyta, chlorophyta. Seaweeds - classification and distribution. Sea grasses and mangroves. Deep sea adaptations. Food chain and energy flow in the marine environment. Coral reefs, types and its importance; Destruction of coral reefs causes and consequences.

Suggested readings:

1. Wetzel, R. G. (2002). Limnology Lakes and River Ecosystem. Academic Press, London.
2. Schoworbel, J. (1991). Handbook of limnology. Scientific publ. Jodhpur.
3. Goldman, C. R. and Horne, A. J. (1994). Limnology. Mc. Graw Hill Int. Book Co., New Delhi.
4. Hutchinson, G. E. (2004). Treatise on Limnology. Vol. I, part-2, Vol. II. John Willey and Sons, New York.
5. Jhingran, V. G. (1992). Fish and Fishes of India. Hindustan Publishing Corporation, India.
6. Aggarwal, S. C. (1999). Limnology. APH Publ. Corp., New Delhi.
7. Bal, A.S (2005). An Introduction to Environment Management. Himalaya Publishing House, Mumbai.
8. India's Wetlands Mangroves and Coral Reefs (1992). WWF India.
9. Dugan, P. (1993). A Mitchell Beazley World Conservation Atlas. Wetlands in Danger. Mitchell Beazley, London.
10. Abbasi, S. A. (1997). Wetlands of India. Discovery Publishing House. New Delhi.
11. Sinha, P. C. and Mohanty, R. (2002). Wetland Management Policy and Law. Kanishka Publishers, Distributors, New Delhi.
12. Garg, S. K. (1998). Hydrology and water resources engineering. Khanna Publishers, Delhi

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – I (Elective Course)		
Course Title: Natural Resources & its Management		Course Code: PG-EVS-E1.1
Credits: 04	Paper - IV	Max. Marks: 100

Unit – I: Non-Conventional Resources

15 Hours

Natural Resources: Definition, Classification, concepts and distribution of natural resource in India and global level. Importance and applications of natural resources, Conservation and Management- Definition, Broad Classification, Renewable, Non Renewable and Mineral Resources. Renewable (Non-Conventional Source of Energy). Principles of generation of Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Biomass energy (Bio Gas), Ocean Energy and Magneto- hydrodynamic Power (MHD), Impact on Environment and their applications.

Unit – II: Conventional & Water Resources

15 Hours

Non Renewable (Conventional Source of energy): Thermal Power, Hydro Energy, Atomic Energy, Nuclear Energy (Fission and Fusion) and Fossil fuels (Coal, Petroleum Oil and natural Gas). Water resources: utilization of surfaces and ground water Crisis of Water, consequences of over exploitation. Integrated water resources management. Watershed Management- Rain Water Harvesting. National lake and river conservation programme. Wetland management. Coastal zone management- Concept, scope, issues and strategies.

Unit – III: Mineral & Bio Resources

15 Hours

Mineral resources and reserves, ocean ore and recycling of resources, Ocean as new area for exploration of mineral resources, Environmental impact of exploitation, processing and smelting of minerals. Energy Production Consumption and Energy use pertain in different part of the world. Application of biomass technology to increase the hydrocarbon chain. Pyrolysis. Biogas from solid waste. Biofuels. Conservation of Energy - Importance, Methods of Conservation, Barriers to Energy Conservation, Measures for Promoting Energy Conservation, Eco-Friendly Energy Sources, Energy Audit.

Unit – IV: Forest Resources

15 Hours

Forest Resources: Forest resource Management: Importance of Forestry, forest products, Forest based medicinal & Pharmaceutical Industries. Forest management practices and programmes. Afforestation and Joint Forest Management – Social Forestry, Agro-Forestry, urban forestry. Protected forest area management – Eco-development committees and Eco-tourism. Gene pool management. Forest Fire and its Control. Wildlife habitat management. Plants as a natural resource: a general account with reference to herbs, shrubs and grasses of Ladakh. General account of plants used in ethnobotanical purposes in Ladakh

Suggested Readings:

1. Harikesh N Mishra 2014 Managing Natural Resources- Focus on Land and Water. PHI Learning Publication.
2. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
3. Harikesh N, Mishra 2014,. Managing Natural Resources- Focus on Land and Water. PHI Learning Publication.
4. Singh, Rajvir. 2000. Watershed Planning and Management. Yash.
5. Roy, A.B. 2010. Fundamentals of Geology. Narosa.
6. Murthy, V.V.N. 2009. Land and Water Management, 5th edition. Kalyani Publishers.
7. Heathcote, I.W. 1988. Integrated Watershed Management: Principles and Practice. John Wiley.
8. Tiwari, G.N. and M. K. Ghosal. 2005. Renewable Energy Resources: Basic Principles and Application, Narosa Publishing.
9. Edward H. Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-wesley Publishing Company, Reading.

10. D. D. Mishra (2012) Energy, Environment, Ecology and Society, S. Chand & Company Ltd. New Delhi
11. C. S. Solanki (2009), Renewable Energy Technologies-A Practical Guide for Beginners, PHI Learning Pvt. Ltd., New Delhi.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – I (Elective Course)		
Course Title: Soil Biology & Fertility	Course Code: PG-EVS-E1.2	
Credits: 04	Paper - V	Max. Marks: 100

Unit – I: Soil biology

15 Hours

Soil biota; soil microbial ecology; types of organisms in different soils; soil microbial biomass; microbial interactions; un-cultivable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes – origin, activities and importance; soil characteristics influencing growth and activity of microflora. Biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and Vermicompost. Biofertilizers-definition, classification, specification, method of production and role in crop production. biological nitrogen fixation; nitrogenous fertilizers and their fate in soils.

Unit – II: Soil Fertility

15 Hours

Definition of Soil and Soils as a Natural Body. Soil Components-Air, Water, Inorganic, and Organic Solids. Physicochemical properties of soil. Composition of soil air; renewal of soil air, diffusion; measurement of soil aeration; aeration requirement and management for plant growth. Energy transfer in soils; energy balance; thermal properties of soil; measurement; soil temperature in relation to plant growth and management. Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Law of soil fertility soil.

Unit – III: Soil Fertilizer Use

15 Hours

Nitrogenous fertilizers and their fate in soils; management of nitrogenous fertilizers. Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting on availability in soils; phosphatic fertilizers -behaviour in soils and management under field conditions. Potassium - forms, equilibrium in soils and its significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions. Sulphur, Calcium and Magnesium- source, forms, fertilizers and their behaviour in soils; factors affecting their availability in soils; management of fertilizers. Micronutrients – critical limits in soils and plants.

Unit – IV: Fertilizer Technology

15 Hours

Fertilizers- production, consumption and future projects with regard to nutrient use in the country and respective states: fertilizer control order. Manufacturing process for different fertilizers using various raw materials, characteristics and nutrient contents. Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order. New and emerging issues in fertilizer technology- production and use of slow and controlled release fertilizers, super granules fertilizers and fertilizers for specific crops/situations.

Suggested Readings:

1. Soil Science Simplified, Khonke and Franzmeier, Waveland Press.
2. Soils and Soil Fertility, Troch, F.R. and Thompson, L.M., Oxford Press.
3. Soil Fertilizer Handbook, The Fertilizer Institute, Washington, D.C. PPI & others.
4. Fundamentals of Soil Science, Foth, H.D., Wiley Books
5. Alexander M. 1977. Introduction to Soil Microbiology. John Wiley & Sons.
6. Metting FB. 1993. Soil Microbial Ecology – Applications in Agricultural and Environmental Management. Marcel Dekker.
7. Reddy MV. (Ed.). Soil Organisms and Litter in the Tropics. Oxford & IBH.
8. Russel RS. 1977. Plant Root System: Their Functions and Interaction with the Soil. ELBS & McGraw Hill.
9. Sylvia DN. 2005. Principles and Applications of Soil Microbiology. Pearson Edu.
10. Stevenson FJ & Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

SEMESTER - II

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – II (Core Course)		
Course Title: Environmental Chemistry & Toxicology	Course Code: PG-EVS-C2.1	
Credits: 04	Paper - I	Max. Marks: 100

Unit – I: Introduction to Environmental Chemistry

15 Hours

Its definition, concept and scope; Fundamentals of chemical reactions - Oxidation, reduction and precipitation. Stoichiometry (mole, molality, molarity and normality); Gibbs' energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, the carbonate system; unsaturated and saturated hydrocarbons and radionuclides; Soil Chemistry - Inorganic and organic components of soils, biogeochemical cycles- Nitrogen, Carbon, Phosphorus and Sulphur.

Unit – II: Atmospheric chemistry

15 Hours

Chemical composition of air, particles, ions and radicals in the atmosphere; Chemistry of air pollutants - primary (CO, SO_x, NO_x & particulates) secondary pollutants (ground level ozone, acid rain, nutrient enrichment); Thermochemical and photochemical reactions in the atmosphere; CFCs, Oxygen and Ozone chemistry; Photochemical smog & Classical smog. Water chemistry - Hydrological cycle and water as a universal solvent; The concept of total pH, dissolved solids (TDS), Total suspended solids (TSS), Total Hardness, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD); Sedimentation, Coagulation, Flocculation and Filtration.

Unit – III: Introduction to toxicology

15 Hours

Definition, concept, scope and sub-disciplines of toxicology; Toxicant and its types, sources of poisoning, acute and chronic toxicity; Toxic chemicals in the environment; Factors influencing toxicity; Biochemical aspects of As, Cd, Pb, Hg, CO, O₃, PAN, MIC and carcinogens in air; Food Additives and Toxicity of Food Additives.

Unit – IV: Xenobiotics

15 Hours

Definition, its types, dose, dose-response relationship, time action curves, threshold limit value and LC50/LD50; Concept of bio-indicator, bioaccumulation, bio-magnification and bioremediation; Toxicology of major pesticides, biotransformation, biomonitoring; Impacts of use of pesticides; Concepts of environmental forensics; Bioassay – concepts, types, characteristics, and importance.

Suggested readings:

1. Biswas T.D and Mukherjee S.K. (1987). *Text book of Soil Science* IV Ed., Mc Graw- Hill.
2. Connell D.W., Lam P. and Richardson B. 1999. *Introduction to Ecotoxicology*. Blackwell Publishing.
3. Sodhi, G.S., 2008. *Fundamental concepts of environmental chemistry*. Alpha Science Int'l Ltd. 3rd Ed.
4. Klaassen C., Watkins. J.B. 2015. *Casarett & Doull's Essentials of Toxicology*, McGraw-Hill Ed. 3. ISBN 10: 0071847081
5. Manahan S.E. (2000). *Environmental Chemistry* (7th Ed), Lewis Publications, Florida, U.S.A.
6. Manahan S.E. (2001). *Fundamentals of Environmental chemistry*, II Ed., CRC Press
7. Sharma, P.D., 2014. *Environmental biology & toxicology*. Rastogi Publications.
8. Roberts, S.M., James, R.C. and Williams, P.L., 2015. *Principles of toxicology: environmental and industrial applications*. John Wiley & Sons.
9. Tyagi O.D. and Mehra M. (1990). *Text Book of Environmental Chemistry*, I Ed., Anmol Publications.
10. Kaur H. (2019). *Environmental Chemistry*, 13th Ed., Pragati Prakashan, Meerut India
11. De Anil, K., 2003. *Environmental chemistry*. New Age International.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – II (Core Course)		
Course Title: Environmental Pollution & Disaster Management	Course Code: PG-EVS-C2.2	
Credits: 04	Paper - II	Max. Marks: 100

Unit – I: Air and Water Pollution

15 Hours

Introduction to Environmental pollution; Natural and anthropogenic sources of pollution. Effect of air pollution on man and environment. Air pollutants: Classification, transport, diffusion and their effects. Greenhouse effect, Acid rain, Photochemical smog and particulates. The characteristics and biochemical effect of some air pollutants. Effects of particulate matter and indoor and occupational pollutants. Introduction to water pollution. Source and types of water pollutants- Organic waste, oxygen demanding waste, diseases causing waste, sewage and agricultural runoff, inorganic pollutants, suspended solid, radioactive materials. Ground and surface water pollution. Characteristic of waste water (Physical, chemical and biological). Primary and secondary treatment of waste water pollution.

Unit – II: Soil and Noise Pollution

15 Hours

Soil pollution and its sources. Effect of soil pollution- Effect on soil due to modern agricultural practices, synthetic fertilizers, pesticides and industrial effluents. Love canal episode. Control of soil pollution. Bioremediation and phytoremediation of contaminated soil and toxic compounds.

Introduction to noise pollution. Source and effect of noise pollution, physiological, psychological, acute and chronic effect of noise pollution. Measurement of noise level, equipment use for it and noise pollution control criteria. Noise control in industrial establishment.

Unit – III: Radioactive Pollution and Nuclear Hazard

15 Hours

Introduction, classification and sources of radioactive pollution. Effect of radiation on living cell. Environmental problem and effects on plant due to radioactive waste. Control measures of radioactive pollutions.

Identification of hazardous waste, management of hazardous waste pollution, treatment and disposal of hazardous chemical waste- physical chemical and biological processes. Offside hazardous waste disposal. Nuclear accidents- Fukushima nuclear disaster and Chernobyl disaster.

Unit – IV: Disaster Management

15 Hours

Introduction to disaster management. Types and management of natural disaster (earthquake; landslides; tsunami; volcanic eruption; avalanches; flood; drought; wildfire and cyclone). Types and management of man-made disaster (Nuclear disaster; chemical disaster; chemical spill and accidents; air, road and water). Bhopal gas tragedy and Minamata tragedy. Disaster management (preparedness, response, medicine and Post-disaster management).

Suggested Readings:

1. A. K. De, "Environmental Chemistry," Wiley Eastern Ltd., New Delhi, 1990
2. Peavy, H., Rowe D. & Tchobanoglous, G. (1985). *Environmental Engineering*. New York: McGraw-Hill.
3. H. Sharma and B. K. Kaur, "Environmental Chemistry," Goel Publishing House, Meerut, 1995.
4. S.S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edition, S. Chand and Sons, New Delhi, 2008
5. Guerisse P. 2005 Basic Principles of Disaster Medical Management. Act Anaesth. Belg; 56:395-401.
6. A.K. Srivastava, 2021. Text book of Disaster Management P/B. Textbook of Applied Entomology Volume 2.
7. An Introduction to Disaster Management Natural Disasters and Man Made Hazards (Pb 2020) by S VAIDYANATHAN.
8. Dr. R. K. Dave, 2018. Disaster Management in India: Challenges and Strategies Hardcover
9. S. K. Shukla & P. R. Srivastava, Water Pollution and Toxicology: Commonwealth Publisher, New Delhi (1992).
10. S V S Rana, Environmental Pollution Health & Toxicology: Narosa Publishing House, New Delhi (2006).

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – II (Core Course)		
Course Title: Meteorology & Global Climate Change	Course Code: PG-EVS-C2.3	
Credits: 04	Paper - III	Max. Marks: 100

Unit-I: Atmospheric Science

15 Hours

Evolution of the earth's atmosphere; Structure and its temperature relationships; Atmospheric stability, Solar radiation and terrestrial radiation; Temperature inversions and wind roses; Coriolis force, pressure gradient force, frictional force, geo-strophic wind, gradient wind; Atmospheric general circulation, Air mass and weather fronts; Weather elements and instruments; Precipitation and its types; Atmospheric disturbances - Thunderstorms, Cyclones, lightning, flood, and drought; Environmental lapse rate, dry and wet adiabatic lapse rate, inversion of temperature and atmospheric stability; heat budget.

Unit – II: Climatology

15 Hours

Definition, scope & aims of climatology; Koppen's climate classification system; Insolation-Factors Affecting the Distribution of Insolation; Atmospheric Depletion of Solar Radiation; Process of Heat Energy Transfer- Radiation, Conduction and Convection; Hydrological cycle - Evaporation, Condensation; Forms of Condensation – Dew, Frost, Fog, Mist, Smog; Cloud Formation, Classification of Clouds and Role of Clouds in Weather Forecasting; Climates of India, Indian monsoon, western disturbances, El Nino effect & La Nina; Heat Islands; Plume characteristics.

Unit – III: Meteorology

15 Hours

Definition, scope & aims of meteorology: Primary Meteorological Parameters and their Measurement - Temperature, Wind Speed and Direction; Secondary Meteorological Parameters and their Measurement - Humidity, Relative Humidity, Absolute Humidity, Pressure and Solar Radiation; Collection and Analysis of Wind Data, Wind Roses, Plotting of Wind Roses and Pollution Roses; Application of GIS in Geo-Environment

Unit – IV: Global Climate Change

15 Hours

Introduction, Sources and effects of Greenhouse Gases – Carbon dioxide, Methane, Ozone, Nitrous oxide, Chlorofluorocarbons and water vapour; Global warming; Stratospheric Ozone and mechanism of Ozone Depletion; Antarctic Ozone Hole and Consequences; Climatic Effects and Environmental Disturbances; Acid rain and its types; UV Radiations, Types and Effects of UV radiations on plants, animals, human health and materials; Advance Research to Protect the Ozone Layer; Concept of Carbon Sequestration.

Suggested Readings:

1. Physical geography (English, INDIGO BOOKS, SAVINDRA SINGH) Binding: INDIGO BOOKS. Publisher: PRAVALIKA PUBLICATIONS. ISBN: 9789432657570, 9432657574. Edition: 2018, 2018
2. Environmental Science: Earth as a Living Planet: Botkin, Daniel B. and Keller, Edward A. 6th ed. John Wiley & Sons, USA. 2007.
3. General Meteorology: H. R. Byers, Tata McGraw Hill Publications, New Delhi.
The Atmosphere: An Introduction to Meteorology: Fedrik K. Lutgen, E. J. Tarbuck.
4. General Meteorology: H. R. Byers (Tata Mc Grew – Hill Publications, New Delhi).
5. Meteorology: Dr. S.R. Gadekar, Agromate Publishers, Nagpur 2000.
6. Atmosphere, Weather and Climate: K. Siddhartha, Kosalaya Publication Pvt. Ltd 2000.
7. Frederick K. Lutgens, Edward J. Tarbuck. 1995. The atmosphere: an introduction to meteorology. Prentice Hall publication.
8. IPCC. 2006. Guidelines for National Greenhouse Gas Inventories. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.

9. John E. Oliver, John J. Hidore. 2002. Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.
10. John T. Hardy. 2003. Climate Change: Causes, Effects and Solution. John Wiley & Sons publications.
11. Botkin D.B. 1989. Changing the Global Environment, Academic Press, San Diago.
12. Howard J. Critchfield. (1983). General Climatology (Fourth Edition), Phi Learning Pvt Ltd.
13. Mark Maslin. 2013. Climate - a very short introduction, Oxford University Press.
14. Roger G. Barry and Richard J. Chorley. 2007. Atmosphere, weather and Climate, 8th Edition, Routledge Publishers.
15. Oliver. 2002. Climatology: An Atmospheric Science, 1st Edition, Pearson Publishers.
16. Mark Maslin. 2008. Global Warming, 2nd Edition, Oxford University Press Publishers -New Delhi.
17. Manoj Singh. 2012. Climatology: Sonali Publications Publisher

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – II (Elective Course)		
Course Title: Solid/Hazardous Waste Management	Course Code: PG-EVS-E2.1	
Credits: 04	Paper - IV	Max. Marks: 100

Unit – I: Introduction to Solid Waste

15 Hours

Definition, Generation and characterization of Special Waste, Domestic waste, slaughterhouse waste, waste tyre, Plastic waste, Industrial waste and Construction & Demolition Waste; Cradle to grave approach - Waste generation, storage, collection, segregation, transfer and transport, processing, recovery and disposal of SWM;

Solid Waste Treatment, Disposal and Management - Introduction, Vermiculture, Composting, Pyrolysis, Gasification, Incineration, Biogas from MSW, 3R's of Solid Waste Management, Bio-methanation, Material Recovery facility (MRFs), Refuse derived fuels; Public Health Aspect Related to Solid Waste; Status of Municipal Solid Waste in India.

Unit – II: Sanitary Landfill

15 Hours

Site Selection, Site Investigation and Site Characterization for Landfill, Landfill Planning and Designing, Construction and Operational Practices, closure and post closure aspects of Landfill, Dumpsite closure or reclamations, Landfill Quality and Control, Merits and demerits of landfill;

Landfill liners - Clay, Geo-membrane, HDPE, Geonet, Geotextile Protection at disposal sites, Impacts of landfill on environment;

Landfill emissions - Leachate and Landfill Gas, Leachate collection & analysis; Landfill gas management; SWM & GHG emission- Linkages to Climate Change.

Unit – III: Hazardous Waste and its Treatment

15 Hours

Definition, classification, Source, identification, and characteristics; Priority Pollutants, Acute and Chronic Toxicity; Mutagenicity, Teratogenicity, Carcinogenicity and Genotoxicity; Packaging requirements under DOT regulations for safe transport of hazardous wastes;

Treatment and disposal methods of HW - Physico-chemical processes, Biological process, stabilization and solidification, Thermal destruction method, Wet Air Oxidation, Land Farming, Bioremediation, Biodegradation of Recalcitrant, Secure landfill;

Unit – IV: Biomedical & E-Waste and its Management

15 Hours

Biomedical Waste Management - Definition, sources, categories of Biomedical waste, Segregation, transportation, treatment and disposal methods; E-Waste & Battery Waste Management - Sources, effects, segregation, recycling treatment and disposal; Identification of Landfill for Hazardous Waste Disposal; Leachate Management, Recycle and Reuse of Hazardous Waste, Recovery of Chemicals from Hazardous Wastes; Remedial Actions of Hazardous Waste; Hazardous Waste – Indian Scenario.

Suggested Readings:

1. Solid Waste Management - A Manual by All India Institute of Local
2. Waste Management Practices (Municipal, Hazardous and industrial). Second Edition. John Pichtel.
3. Toxic and Hazardous Waste by Sinha P.C.
4. Manual on Solid Waste Management by Palnitkar, Sneha
5. Basic Hazardous Waste Management by William C. Blackman
6. Management of Municipal Solid Waste by Ramchandra T. V.
7. Solid Waste Management by H V. Bijalani
8. Handbook of Solid Waste Management. McGraw Hill Publishers, Kreith, F. USA. 2002.
9. Kumar, R and Singh, R.N. Municipal Water and Wastewater Treatment. Capitol Pub. Co., New Delhi. 2006.

10. Noble, G. Sanitary Landfill Design Handbook. Technomic Westport Connecticut, USA. 1976.
11. Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999
12. Vesilind, P. A., Worrell, W. and Reinhart, D. Solid Waste Engineering. Brooks/Cole Thomson Learning Inc., USA. 2002.
13. White, P, Frank, M. and Hindle, P. Integrated Solid Waste Management- A Life Cycle Inventory. Chapman & Hall, USA. 1999.
14. Aradhana Salpekar. Solid waste pollution, Jnanada Prakashan, New Delhi.
15. Lie D.H.F and Liptak B.G. (2000). Hazardous Wastes and Solid Wastes- Lewis publishers, New York.
16. Solid Waste management in Developing countries – Indian National Scientific.
17. Milary Theiren and Samuel A. Solid waste management- George Tehobanaglou-
18. WHO Manual on solid waste management.
19. Charles A. Wentz. (1996). Hazardous waste Management. McGraw –Hill International Edition.
20. Tandon. (1995). Recycling of crop, Abnimal and Human waste in Agriculture. Mc-Graw Hill Publishing Co.

Department of Environmental Science		
University of Ladakh		
Syllabus of M. Sc. Semester – II (Elective Course)		
Course Title: Social Perspective Of Environment	Course Code: PG-EVS-E2.2	
Credits: 04	Paper - V	Max. Marks: 100

Unit - I: Introduction to Environmental Thought and Early Issues in Indian Environmentalism **15 Hours**

Culture, Social Institutions, Social Structure, Classical sociological theory and the environment, traditions of thinking about the environment from deep ecology to modernization, reflections on industrial societies and risk. Indian and global thinkers. Concept of Anthropocene and Anthropocentrism. Natural resource use practices such as agriculture, forestry and water management and impacts of colonial intervention in India, both from the perspective of the state and of communities. Differences across various regions in India.

Unit - II: Issues in Global Environmentalism, Population and Resources **15 Hours**

Lessons from environmental collapses of past societies, Social construction of nature, global inter-connectedness of environmental issues such as climate change, ozone layer depletion, loss of biodiversity, etc., by examining both the nature of the issues and instruments of international environmental negotiations. Historically evolving relationship between population pressures, resource consumption and sustainability. The tragedy of commons debates.

Unit - III: Urbanization, Environment, Technology and Society **15 Hours**

The process of urbanization is explored with respect of the consumption of resources; environmental consequences of urban transformation: waste disposal, Shrinking Urban Green Spaces, pollution (air, water and land) and scarcity of water, Loss of connectedness to nature. Urban Ecosystem, Urban Species, Nature Conservation in Urban Regions. Community-based natural resource management. Agriculture and Domestic Waste and their recycling. Rural Energy System, Conventional – Fire wood, cow dung, Non-Conventional – Biogas. Solar.

Unit - IV: Environmental Risk and Politics in Contemporary India **15 Hours**

The nature of environmental risk that emerges in the wake of modernity and the responses to the same in select national contexts. Introduces a range of policy initiatives and popular struggles around contemporary environmental issues such as forests, wildlife, water, traditional knowledge and environmental resources and pollution.

Suggested Readings

1. Strauss, L.C. 1995. Myth and meaning: Cracking the code of Culture: Schocken, New York.
2. Pickett, S.T.A., J.M. Grove. 2009. Urban Ecosystems: What would Tansley Do? Urban Ecosystems 12: 1-8.
3. Alberti et al. 2003. Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. Bioscience 53(12): 1169-1179.
4. Mchale, M.R., et.al. 2013. Urban Ecology in a developing world: why advanced socioecological theory needs Africa. Frontiers in Ecology and the Environment 11(10): 556-564.
5. Tanner, C.J., et.al. 2014. Urban ecology: advancing science and society. Front Ecol & Environ 12(10): 574-58
6. The class textbook is Urban Ecosystems: Understanding the Human Environment, by R.A. Francis and M.A. Chadwick. 2013. Routledge, 220 p
7. Robbins, P. 2012. Political ecology: A critical introduction. John Wiley & Sons
8. Norton, B. G. 1984. Environmental ethics and weak anthropocentrism. Environmental Ethics 6: 131-148.
9. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
10. Rosencranz, A., Divan, S. & Noble, M.L. Environmental law and policy in India. 2001. Tripathi 1992.
11. World Commission on Environment and Development. 1987. Our Common Future. Oxford: Oxford University Press.
12. Benedict, Ruth, 2005. Patterns of Culture: Houghton Mifflin Harcourt, New York.

14. Chokkan, K.B., Pandya, H. and Raghunathan, H. (Eds). 2004. Understanding Environment. Sagar publication India Pvt. Ltd., New Delhi, London.
15. Guha, R. 2006. How Much Should a Person Consume, University of California Press.
16. Harper, C., Harper, C.L. and Snowden, M. 2017. Environment And Society: Human Perspectives On Environmental Issues. Routledge.
17. Hobswan, E J., Industry and Empire: From 1750 to present day, Penguin, 1999.
18. Hukkinen, J.I. 2012. Social networks and natural resource management: uncovering the social fabric of environmental governance. *Journal of Integrative Environmental Sciences*, 9:279-281.
19. Leach, M., Stirling, A.C. and Scoones, I. 2010. Dynamic Sustainabilities: Technology, Environment, Social Justice. Routledge.
20. McNiell, J.R. 2002. Something New Under the Sun: An Environmental History of 20th Century, Penguin Press, Allen Lane.
21. Sharma, S. 2009. Why People protest: an analysis of ecological movements in the third World, Publication Division, Govt. of India, Delhi.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – II (Generic Course)		
Course Title: Occupational Hazards		Course Code: PG-EVS-G2.1
Credits: 02	Paper - VI	Max. Marks: 100

Unit - I: Introduction, Problems & Measures

15 hours

Occupational hazards- Physical hazards, chemical hazards, biological hazards & ergonomic hazards. Occupational diseases- Pneumoconiosis- silicosis, Anthracosis, Byssinosis, Bagassosis, Farmers lung, Lead poisoning, Occupational cancer, Occupational Dermatitis, Radiation hazards. Occupational hazards of agricultural workers- somatic diseases, respiratory diseases, sickness, absenteeism, health problems due to industrialization. Measures for health protection of workers, prevention of occupational diseases. Human health problems due to pollution, public health programs, food poisoning - types of food poisoning prevention and control, indicators of health.

Unit - II: Control & Legislation

15 Hours

Occupational health surveillance, Control programmes in the context of Indian Factories Act - case studies. Epidemiology and Public health - Principles of Epidemiology, Epidemiology and control of diseases caused by important microbes in water, air, milk and soil. Status of communicable diseases in India. Administration of public health in India. Public health Legislation- The Factories Act, 1948. Industrial safety standards and regulations. Accidents – definitions - prevention and control. Concepts of safety management systems- EMS ISO 18000 and ISO 22000 series. OSHA - Law & Regulations. Public Liability Insurance Act, Mining Act.

Suggested Readings:

1. Benjamin O. Fundamental principles of occupational health and safety.
2. Louis J. Diberardinis. Alli Handbook of Occupational Safety and Health.
3. Keith Smith and David N. Petley. Environmental Hazards: Assessing Risk and Reducing Disaster.
4. Peter H. Wald, Gregg M. Stave Proctor and Hughes. Physical and Biological Hazards of the work place.
5. Gloria J. Hathaway, Nick H. Proctor, James P. Hughes. Chemical Hazards of the Workplace.
6. G. K. Kulakarni. Implementation of occupational health legislation at work place, issues and concerns.

SEMESTER - III

Department of Environmental Science		
University of Ladakh		
Syllabus of M. Sc. Semester – III (Core Course)		
Course Title: EIA, Auditing & Environmental Awareness		Course Code: PG-EVS-C3.1
Credits: 04	Paper - I	Max. Marks: 100

Unit-I: Introduction to Environmental Impact Assessment

15 Hours

Environmental impact statement & environmental management plan, EIA guidelines: notification of the Government of India, and amendments from time to time various appendices and forms for application, Environmental Clearance, Types of Project activities requiring Environmental Clearance, Procedure of Public hearing, Composition of EAC, SEAC Influence of EIA on projects and organizations, Benefits and future of EIA, Generic structure of EIA Document.

Unit-II: EIA In Project Planning and Implementation

15 Hours

Component of EIA, Project screening, scoping, base-line data, impact identification; prediction, evaluation, Significant environmental impacts, stages of environmental impact analysis, mitigation, Public consultation, presentation, review and decision making, Checklist for EIA, Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost benefit analysis. Mitigation of Impacts, Measurement of environmental impacts, Impact assessment methods adhoc method, Overlay method, matrix and network method analysis, Role of GIS in EIA.

Unit-III: Introduction to Environment Auditing

15 Hours

Objectives of auditing, Environmental Planning as a part of EIA and Environmental Audit, Environmental audit process and methods, steps in environmental auditing, Benefits of auditing, Environment Audit report, Green Audit, Environmental Management System Standards (ISO14000 series), Smart Cities & Green Building Concept in India, Components of Green Building, benefit of green building, Indian green building council, IGBC rating systems, Solar passive buildings

Unit-IV: Environment Education and Awareness

15 Hours

Benefits, Guiding Principles of Environmental Education, Environment Information, Need of Public Awareness about Environment, Important Environment related day celebrations, themes and importance, ICT tools in Environment education, Green good deeds, Eco clubs, Environment Justice, National Green Tribunal, Environment footprints, Environmental Social Responsibility.

Suggested Readings

1. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.
2. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006
3. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/Engineering/Math, New York;
4. Fischer, T. B. (2007). Theory and Practice of Strategic Environmental Assessment, Earthscan, London.
5. Lawrence, D. P. (2003) Environmental Impact Assessment: practical solutions to recurrent problems, John Wiley & Sons, Hoboken NJ;
6. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
7. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford;
8. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
9. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester

10. Wood, C. (2003) Environmental Impact Assessment – A Comparative Review, Prentice Hall, London.
11. Association, B.M., 2013. Health and Environmental Impact Assessment: An Integrated Approach. Routledge.
12. Biswas, A.K., Agarwal, S.B.C., 2013. Environmental Impact Assessment for Developing Countries. Elsevier. .
13. Glasson, J., Therivel, R., Chadwick, A., 2013. Introduction To Environmental Impact Assessment. Routledge.
14. Mareddy, A.R., Shah, A., Davergave, N., 2017. Environmental Impact Assessment: Theory and Practice. Butterworth-Heinemann.
15. Marsden, S., Koivurova, T., 2013. Transboundary Environmental Impact Assessment in the European Union: The Espoo Convention and its Kiev Protocol on Strategic Environmental Assessment. Routledge.
16. Murthy, D.B.N., 2004. Environmental Awareness & Protection : A Basic Book on EVS. Deep and Deep Publications.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – III (Core Course)		
Course Title: Biodiversity & its Conservation		Course Code: PG-EVS-C3.2
Credits: 04	Paper - II	Max. Marks: 100

Unit I: Introduction to Biodiversity

15 Hours

Concepts & Its Levels, Overview of World's Biological Diversity, Significance, Magnitude and Distribution. Biodiversity Trends, Methods for Monitoring Biodiversity Trends. Sampling Strategies and Surveys: Floristic, Faunal, and Aquatic; Qualitative and Quantitative Methods: Scoring, Habitat Assessment, Richness, Density, Frequency, Abundance, Evenness, Diversity, Biomass Estimation; Megadiversity Zones and Hot Spots of world, Concepts, Distribution And Importance. Economic, Social, Aesthetic, Consumptive and Ethical Values of Biodiversity.

Unit-II: Biodiversity of Ladakh

15 Hours

Introduction, Flora and Fauna, IUCN Red and Green Data List Of Ladakh, Wetlands of Ladakh and Its Floral & Faunal Diversity, List of Medicinal Plants in Ladakh, Endemic Species, Land-Use and Agriculture Practices in Ladakh, Biodiversity of Ladakh Rivers. Threats to Biodiversity of Ladakh, Human-Wildlife Conflict, Poaching, Over Exploitation of Natural Resources, Conservation Strategies of Ladakh Biodiversity, Traditional Usage of Wild Flora. State Animal & Bird of Ladakh. Traditional Method of Conservation of Natural Resources. NGO's Working on Conservation of Biodiversity in Ladakh.

Unit-III: Threats to Biodiversity

15 Hours

Major Causes, Extinction's, Vulnerability of Species to Extinction, IUCN Threat Categories, Red Data Book, Green Data Book. Theory of Reserve Design. IUCN Categories of Animals and Plants. Habitat Loss, Habitat Fragmentation, Poaching & Human-Wildlife Conflict. Megadiversity Zones, India as a Mega Diversity Nation, Concepts, Distribution and Importance. Strategies for Sustainable Exploitation of Biodiversity. Biological Invasion, Biopiracy. Climate Change & Biodiversity.

Unit-IV: Biodiversity Conservation

15 Hours

Ex Situ And In Situ Conservation Strategies. Concept Of Protected Areas: National Parks, Wildlife Sanctuaries, Biosphere Reserves, Sacred Groves. Managing Protected Areas, Conservation Outside Protected Areas. Conservation Of Forests: Plantation Programmes In India, Joint Forest Management. People's Biodiversity Register, Restoration Of Biodiversity, Reintroduction Of Biota. Conservation Of Wetlands. Wildlife Conservation: Preservation Of Breeding Stock; Artificial Stocking; Project Tiger, Project Elephant; Crocodile Conservation; Sea Turtle Project, Indo-Rhino Vision.

Suggested Readings:

1. Hunter M.L. and Gibbs J.P. 2007. Fundamentals of Conservation Biology. Third Edition. Blackwell Publishing
2. Daily, G.C., Ed. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C.
3. Dobson, A.P. 1996. Conservation and Biodiversity. Scientific American Library, New York, NY. Groombridge, B., and M. Jenkins. 2000. Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.
4. Ahmed, N. (2002) Bio-diversity Conservation & Sustainable Development: Impact of Infrastructure Development on Bio-Diversity & Recommendations for Action. Paper presented at the Bio-diversity Strategy & Action Plan Workshop organised by Ladakh Ecological Development Group (LEDeG), Leh on 17-18 October 2002
5. Anon. (1993) Directory of Asian Wetlands, New Delhi: WWF India and Kuala Lumpur: AWB.
6. Anon. (1998a) Operational Guidelines for the Implementation of the World Heritage Convention. UNESCO, Paris.
7. Anon (2001b) Statistical Hand Book, District Leh 1999-2000. District Statistical & Evaluation Agency (LAHDC) Leh.

8. Anon. (2001a) Conserving Bio-Diversity in the Trans-Himalaya: New Initiatives of Field Conservation in Ladakh. First annual Technical Report (1999-2000), Wildlife Institute of India, International Snow Leopard Trust and US Fish and Wildlife Service
9. Ganhar, J.N. (1979) The Wildlife of Ladakh. Haramukh Publications. Srinagar
10. IUCN. 2004. Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland
11. Loreau, M., and Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
12. Pandit, M.K. 2017. Life in the Himalaya: An Ecosystem at Risk. Harvard University Press.
13. Primack, R.B., 2002, Essentials of Conservation Biology, 3rd Edn., Sinauer Associates, Sunderland, Ma. USA.
14. Sodhi, N. S., Gibson, L., and Raven, P. H. 2013. Conservation Biology: Voices from the Tropics. John Wiley and Sons Ltd.: UK.
15. Wilson, Edward O. 1993. Diversity of Life. Harvard University Press, Cambridge, MA.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – III (Core Course)		
Course Title: Environmental Technology, Hygiene & Instrumentation	Course Code: PG-EVS-C3.3	
Credits: 04	Paper - III	Max. Marks: 100

Unit-I: Remote Sensing And Geographic Information System (GIS)

15 Hours

Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation. Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies. Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

Unit-II: Green Technology

15 Hours

Definition and concepts: green technology, Green House Gas (GHG) emissions reduction, carbon capture and storage (CCS) technologies, fuel efficient vehicles. Biomass utilization for bio-fuel production and their application. Availability of bio mass and their applications in different places. Familiarization with different types of biogas plants and gasifiers, bio alcohol, biodiesel, Briquetting techniques. Introduction of solar energy, solar collectors and their application, Passive solar house. Familiarization with solar energy gadgets: solar cooker, solar water heater, Application of solar energy: solar drying, solar distillation, solar photovoltaic system and their application.

Unit-III: Environmental Health And Hygiene

15 Hours

Components of environment, importance of healthy environment, Sources of water supply and water quality. Sources of water contamination. Bacteriology of water. Physical, chemical, microbiological and biological evaluation of water. Water purification. Disposal of sewage and farm wastes, Water born disease. Health implications of farm wastes. Sanitation and disinfection of animal houses. Recycling of farm wastes. Prevention and control of air and water-borne diseases. Tannery, wool, bone and blood meal industry pollution and its control. Stray and fallen animal management. Community organizations to promote environmental health. Legislations and acts regulating the environmental hygiene.

Unit-IV: General Instrumentation

15 Hours

Definition, techniques and scope of instrumentation, Microscopy: principal, type and application of microscope, Phase contrast, scanning and transmission electron microscope, Principle and application of centrifuges, Types of centrifuges, Principle and application of electrophoresis, General idea of NMR (Nuclear magnetic resonance spectroscopy). Principles and application of spectroscopy, UV- VIS Spectrophotometer, Principle and application of Flame photometer, Atomic Absorption spectrophotometer, Fourier Transmission Infra-red (FTIR) spectrophotometer, Air sampler (PM 2.5 and PM10, CO monitor). Principle and application of chromatography and its types.

Suggested readings:

1. Anji Reddy M. (2000). Remote Sensing and Geographical Information Systems: An Introduction. Book Syndicate.
2. Robert G. Reeves (Ed). (1983), Manual of Remote Sensing, John Wiley and Sons, New York.
3. Lillesand and Kiefer. (1993). Principles of Remote Sensing
4. Rajan M.S. (1991). Remote Sensing and GIS for Natural Resources.
5. Muralikrishna I.V. (2001). Spatial Information Technology- RS and GIS. Vol.I and II BS Publications, Hyderabad.
6. Burrough P.A. (1986). Principles of GIS for Land Resource Assessment. Oxford University Press.
7. Chatwal, G. R., and Anand, S. K. Instrumental Methods of Chemical Analysis. Himalaya Publishing House, Delhi. 2007.

8. De, A.K. Environmental Chemistry, New Age International, New Delhi. 2000.
9. Murphy, W.J. Analytical Chemistry, American Chemical Society, USA. 1977.
10. Anjaneyulu Y. Introduction to Environmental Science. B.S Publication.
11. Peavy HS, Rowe DR. Environmental Engineering. McGraw Hill.
12. Gupta PK. 2004. Methods in Environmental analysis - water, soil and air. Agrobios (India), Jodhpur.
13. Dara SS. A text book of Environmental Chemistry and Pollution Control.
14. Twidell, John. Renewable Energy Resources.
15. Kothari, D. P. Renewable Energy Sources and Emerging Technologies.
16. Burrough, P.A., McDonnell, R.A. and Lloyd, C.D. 2015. Principles of Geographical Information Systems. Oxford University Press.
17. Lillesand, T.M. & Kiefer. R.W. 1999. Remote sensing and image interpretation (4thEd). Wiley.
18. Thangavel, P. & Sridevi, G. 2015. *Environmental Sustainability: Role of Green Technologies*. Springer Publications.
19. Woolley, T. & Kimmins, S. 2002. *Green Building Handbook* (Volume 1 and 2). Spon Press.
20. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. *Green technologies for a more sustainable agriculture* (No. 33721). United States Department of Agriculture, Economic Research Service.
21. Baker, S. 2006. *Sustainable Development*. Routledge Press.
22. Arceivala, S.L. 2014. *Green Technologies: For a Better Future*. Mc-Graw Hill Publications.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – III (Elective Course)		
Course Title: Environmental Legislation, Treaties, Pollution & Sustainability	Course Code: PG-EVS-E3.1	
Credits: 04	Paper - IV	Max. Marks: 100

Unit-I: Environmental Legislation

15 Hours

Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008. Municipal Solid Wastes (Management and Handling) Rules, 2000. Bio-Medical Waste (Management and Handling) Rules, 1998. Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs) and its role in control of environmental pollution in India. Public Liability Insurance Act, 1991. The Biological Diversity Act, 2002. National Green Tribunal Act 2010. E-Waste (Management and Handling) Rules, 2011. Batteries (Management & Handling) Rules, 2001

Unit-II: Environmental Treaties and Conventions

15 Hours

Role of international Environmental Agencies-UNEP, GEF, UNFCCC and IPCC. CITES (1971), Bonn Convention (1979), UN Conference on the Human Environment in Stockholm, Sweden (1972), Vienna Convention (1985), Montreal Protocol (1987), Basel Convention (1989), Earth Summit/UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil (1992), Convention on Biological Diversity (1992), UNCCD 1994 - Convention to Combat Desertification, Kyoto Protocol (1997), Rotterdam Convention (1998), Cartagena Protocol on Biosafety (2000), World Summit on Sustainable Development (WSSD) in Johannesburg (2002), The Nagoya Protocol (2010) UN Conference on Sustainable Development (UNCSD) or “Rio+20,” (2012), UN-REDD (2008), (COP’s).

Unit-III: Human Population and Environment

15 Hours

Definition of demography, source of demographic information, world population, history of global population growth, variation among nations, population in India, population growth, growth curve, environmental resistance, growth variation among nations, population explosion and arising concerns, impacts of population explosion on the environment, population growth in India, family welfare programme in India, national population policy, family planning methods. Environment and Human Health: carrying capacity, population density, ecological footprint, overpopulation and urbanization. Human rights: Universal Declaration of human rights, human rights and environment.

Unit-IV: Sustainable Development

15 Hours

Sustainable development: concept, objectives and principles. Challenges for sustainable development: Social, Political and Economic considerations, Role of individual and community in Sustainable development. Concept of development, Gross domestic product (GDP), Sustainable Development Goals (SDG), Clean Development Mechanism (CDM), Millennium Development Goals, the Environmental Kuznets’ Curve. Concept of Environmental Economics and its scope. Basic Market process, Market Failure and Externality, case of environmental problems. Estimation of Environmental Costs and Benefits, Cost Benefit Analysis. Valuation of ecosystem services. Intellectual property right (IPR).

Suggested Readings:

1. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
2. Chasek, P. S. The Global Environment in the Twenty-First Century - Prospects for International Co-operation. Indian Reprint by Manas Publications, New Delhi. 2004.
3. Dodds, F. (ed.). Earth Summit. 2002. A New Deal. Earthscan Publications Ltd., UK. 2002.
4. Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley & Sons, USA. 2003.

5. Harris, F. *Global Environmental Issues*. Wiley & Sons, Inc., USA. 2004.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi, India. 2006.
7. Speth, J. C. *Global Environmental Challenges – Transitions to a Sustainable World*. Orient Longman Pvt. Ltd., New Delhi. 2004.
8. UNEP (United Nations Environment Programme). *Agenda21*. Available online at <http://www.unep.org/Documents.Multilingual/Default.asp?documentID=52>
9. UNEP. *Global Environmental Outlook 3: Past, Present and Future*. Earthscan Publications. 2002.
10. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.
11. Mark Maslin. 2008. *Global Warming*, 2nd Edition, Oxford University Press Publishers -New Delhi.
12. Anne Bayley and Tracey Strange. (2010). *Sustainable Development: Linking Economy, Society, Environment*, Academic Foundation Publishers.
13. Sundar I. (2006). *Environment and Sustainable Development*, 1st Edition, APH Publishing Corporations Publishers.
14. Bhattacharya Rabindranath (Ed). (2002). *Environmental Economics: An Indian Perspective*, 1st Edition, Oxford University Press Publishers.
15. *Eco-Efficiency: The Business link to Sustainable Development* by Livio Desimone.
16. Sakarama Somayaji. (2011). *Environmental Concerns and Sustainable Development: Some perspectives from India*. TERI Press.
17. Bell, S.&McGillvray, D. 2001. *Environmental Law*, Universal Law Publishing Co.
18. Divan, S.&Rosencrantz, A. (eds). 2001. *Environmental Law and Policy in India: Cases, Materials and Statutes*. New Delhi: Oxford University Press.
19. Jariwala C.M. 2004. *Environmental Justice*, APH Publishing Corporation, N. Delhi
20. Mohanty. S. K. 2004. *Environment and Pollution Law*, Universal Law Publishing Co. Pvt. Ltd.
21. Percival, R.V., Schroeder, C.H., Miller, A.S. and Leape, J.P. 2017. *Environmental Regulation: Law, Science, and Policy*. Wolters Kluwer Law & Business.
22. Rajamani, L. 2006. *Differential Treatment in International Environmental Law*. Oxford University Press: New Delhi.
23. Rengarajan, S., Palaniyappan, D., Ramachandran, P. and Ramachandran, R. 2018. National Green Tribunal of India—an observation from environmental judgements. *Environmental Science and Pollution Research*, pp.1-6.
24. Singh, G. 2004. *Environmental Law in India*, Mcmillan& Co. Shastri, S. C. 2005. *Environmental Law*, Eastern Book Company. White, R. ed., 2017. *Transnational Environmental Crime*. Routledge.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – III (Elective Course)		
Course Title: Forest Ecology		Course Code: PG-EVS-E3.2
Credits: 04	Paper - V	Max. Marks: 100

Unit – I: Introduction to Forestry

15 Hours

Forests definitions. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests. Introduction to world forests - geographical distribution and their classification. Forest biomass, Basic concepts on Forest types in India. Forest Mensuration, tree diameter (DBH) and height measurement, canopy. Direct and indirect benefit of forest. Status of forests in India and their role. Forest survey of India report.

Unit – II: Agroforestry System and Management

15 Hours

Agroforestry - definition, aims, objectives and need. Traditional agroforestry systems. Alley cropping, high density short rotation plantation systems and energy plantations. Classification of agroforestry system -structural, functional, socio-economic and ecological basis. Multipurpose tree species and their characteristics. Agroforestry systems in different agro-climatic zones, components, production and management techniques. People participation, rural entrepreneurship through agroforestry and industrial linkages. Financial and socio-economic analysis of agroforestry systems

Unit – III: Plantation Forestry

15 Hours

Definition and scope of Plantation forests - planting plan, plantation records. Plantation establishment -legal title of land, survey, site selection. Site preparation - purpose and methods. Planting - layout, time of planting, planting pattern, spacing, gap filling, planting methods, direct seeding. Choice of species on ecological aspects - afforestation of dry land, wet land, other adverse sites. Enrichment planting, nurse and cover crops. Plantation maintenance - weed control, climber cutting, staking. Thinning - definition, objectives. Effect of methods of thinning on stand development. Energy and industrial plantation - definition, scope, species, establishment, management and impact on environment. Plantation economics.

Unit – IV: Forest Management, Policy and Legislation

15 Hours

Introduction: definition and scope. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section. Yield regulation – general principles of even aged and uneven aged forest crop. Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope. Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of Special Forest Law. Indian Forest Act. Detailed study of IFA, 1927.

Suggested readings:

1. Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998). Forest ecology (4th edition). John Wiley and Sons
2. Burton V. Barnes, Donald R. Zak, Shirley R. Denton, Stephen H. Spurr. 1998. Forest Ecology. John Wiley & Sons
3. Champion, H.G. and Seth, S.K. (1968). A revised survey of the forest types of India (Reprinted 2004). Natraj Publicaiton, Dehradun.
4. FSI (2009). State of forest report 2009. Forest Survey of India, Dehradun.
5. Kimmins, J.P. (2004). Forest ecology (2nd edition). Pearson Education.
6. Ravindranath, N.H. (2004). Joint forest management in India. Oxford University Press.
7. Dwivedi A.P. (1992) Agroforestry: Principles and Practices. Oxford & IBH.
8. Jha, L. K. (2009) Advances in Agroforestry, APH Publishing Cooperation, New Delhi.
9. Nair P.K.R., Rai M.R. & Buck LE. (2004) New Vistas in Agroforestry. Kluwer.
10. Nair P.K.R. (1993) An Introduction to Agroforestry. Kluwer.
11. Ong C.K. & Huxley P.K. (1996) Tree Crop Interactions – A Physiological Approach, ICRAF. Young A. (1997) Agroforestry for Soil Management, CABI.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – III (Generic)		
Course Title: Environmental Economics		Course Code: PG-EVS-G3.1
Credits: 02	Paper - VI	Max. Marks: 100

Unit– I: Introduction

15 Hours

An Introduction to Environmental Economics, Environment & Elements of Ecology, Common Property Resources, Market Failure Analysis: Public Goods & Externalities, Benefit-Cost Analysis, Evolution of Environmental Policy and Economics, Introduction to the theory of environmental policy: a simple model of damages and cost, property rights and the Coase Theorem, environmental policy instruments, aggregate marginal abatement cost curve. Environmental Accounting Concept.

Unit – II: Economic Risk and Management

15 Hours

Economic and ecological consequences of genetically engineered organisms, intellectual property rights, Environmental Regulations in India, Environmental Risk Analysis-Concept of Risk, Risk Assessment and Risk Management, International Trade and International Agreement, Climate Change and economic development, Sustainable Development Concept and Measurement, Sustainable Development Goals. Poverty, Income Distribution and Environment.

Suggested Readings:

1. Bhattacharya, R.N. (Ed). 2001. Environmental Economics: An Indian Perspective. Oxford University Press.
2. Bromley, D.W. (Ed). 1995. Handbook of Environmental Economics. Blackwell.
3. Hanley, N., Shogren, J.F. and White, B. 2002. Environmental Economics in Theory and Practice. Palgrave Macmillan.
4. Kadekodi, G.K., (Ed). 2004. Environmental Economics & Practice. Oxford University Press.
5. Kolstad, C. 2000. Environmental Economics. Oxford University Press.
6. Martinez-Alier, J. and Muradian, R. (eds). 2015. Handbook of Ecological Economics, Edward Elgar.
7. Tietenberg, T. 2003, Environmental and Natural Resource Economics (6th ed), Pearson Education.
8. Jhingan M.L. (2009). Environmental Economics - Theory, Management & Policy, 2nd Edition. Vrinda Publications PLT-Delhi Publishers.
9. Anil Shishodia. (2007). Environmental Economics: Theory and Applications, Sage Publications India Pvt. Ltd. Publishers.

SEMESTER - IV

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – IV (Core Course)		
Course Title: Biostatistics, Research, Restoration & Mountain Ecology	Course Code: PG-EVS-C4.1	
Credits: 04	Paper - I	Max. Marks: 100

Unit-I: Biostatistics and Computer Application

15 Hours

Biostatistics basic definition and its applications in environmental sciences, Data Collection, data cleaning and representation of data, Formation of table, data plotting, type of graph etc. Measure of central tendencies (Mean, Median and Mode), Measure of Skewness and Kurtosis, Measure of variability (standard deviation, standard error, range). Sampling parameters, attributes and variable types, Difference between sample and Population, Sampling Errors. Hypothesis and its Types. Hypothesis Testing: T -Test, Z Test, Chi -Square Test. Use of computer for preparing and presenting documents, Statistical packages, internet uses and search of literature, Program of MS Office, Excel and Power point presentation.

Unit-II: Research Methodology

15 Hours

Basic principles and significance of research design, Overview of Scientific Writing, Thesis & its components, Oral and poster presentation of scientific results. Concept of research articles, Aspects of Scientific English, Proofreading /Editing of the paper, List of important journals in different fields of Environment; Concept of Impact factor; H-Index. Authors and their rights, International Standard Serial Number (ISSN) and International Standard Book Number (ISBN), Publishers and Publishing agreement, Plagiarism, Cheating / academic frauds; Censoring, biosafety Grant and Funding Proposals, Funding agencies, Intellectual property rights & Patents.

Unit-III: Restoration Ecology

15 Hours

Ecology of Disturbed Ecosystems: disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems. Degraded ecosystem, Aims and strategies of restoration: Concepts of restoration, single vs. multiple end-points; ecosystem reconstructions; physical, chemical, biological and biotechnological tools of restoration. Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota. Degradation and restoration of natural ecosystems: Terrestrial & Aquatic. Civic education, Biological augmentation, Microbes & restoration. Restoration of degraded soils: Restoration of contaminated soils and soil fertility, mine spoil restoration. Restoration projects (case studies).

Unit-IV: Mountain Ecology

15 Hours

Definition, importance and scope of Mountain Ecology, Environmental importance of mountains. Mountain Ecosystem: Structure and its components. Geological formations of mountains, Vulnerability of mountain ecosystems, Environmental degradation in mountains. Environmental Hazards in the Mountains: Landslides, soil erosion and sedimentation, Cloud bursts, Flash floods and river blockades, Avalanches and Glaciers Lake Outburst Floods (GLOF), Earthquakes, Forest fires, Natural resources of mountains (Forest, Water, Wildlife and Minerals), Sustainable exploitation of natural resources, National and international efforts for management of mountains Indigenous people of mountains, Livelihood of mountain people, Migration of mountain people, Livelihood security of mountain people.

Suggested Readings:

1. Johnson. R.A. Bhattacharyya. G.K. (2009). Statistics: Principles and Methods, John Wiley and Sons, USA.
2. Micheal C.J. (2005). Statistics: An Introduction. R, John Wiley and Sons, USA.
3. Kothari, C.R. Research Methodology – Methods and Techniques. 2nd revised ed. New Age International (P) Ltd. Publishers, New Delhi. 2007.
4. Aggarwal, Y.P. Statistical Methods – Concepts, Applications and Computations. Sterling Publications Pvt. Ltd., Bangalore. 1986.

5. Bailey, N.T.J. *Statistical Methods in Biology*. 3rd ed. Cambridge University Press, Cambridge, UK. 1994.
6. Banerjee, P.K. *Introduction to Biostatistics*. S. Chand and Co., New Delhi. 2004
7. Gerstman, B.B. *Basic Biostatics – Statistics for Public Health Practice*. Janes and Bartlett Pub.,
8. Selvin, S. *Biostatistics – How it Works*. First Impression. Pearson Education Inc., New Delhi. 2007.
9. Rastogi, V.B. *Fundamentals of Biostatistics*. Ane Books India, New Delhi. 2007.
10. Andre F. Clewell and James Aronson, 2008. *Ecological Restoration: Principles, Values, and Structure of an Emerging Profession*. Island Press.
11. Sigurdur Greippson, 2010. *Restoration Ecology*. Published by Jones & Bartlett, Ecology Ed. Edition.
12. Margaret A. Palmer, 2016. *Foundations of Restoration Ecology*. Island Press, 2nd Edition.
13. Allison, S. K. 2014. *Ecological restoration and environmental change: Renewing damaged ecosystems*. Routledge.
14. Bainbridge, D. A. 2007. *A guide for desert and dryland restoration new hope for arid lands*. Pages 391 p. Island Press, Washington, D.C.
15. Cooke, G. D. 2005. *Restoration and management of lakes and reservoirs*. 3rd edition. CRC Press, Boca Raton, FL.
16. Ramola Parish, 2001. *Mountain Environments*. Routledge Publisher.
17. Ed Douglas, 2021. *Himalaya – A Human History*. Published by W.W. Norton & Company.
18. S.S. Negi, 2014. *Mountain Ecosystems of Inida*. Published by Bishen Singh Mahindra Pal Singh, First Edition.
19. Barry, R.G., 1992, *Mountain, weather and climate*, London: Routledge.
20. Jodha, N. S. 2000. *Globalization and fragile Mountain Environment: Policy challenges and choices*. *Mountain Research and Development* 20(4): 296-299.
21. Messerli, B. and J.D. Ives (Eds.) 2004. *Mountains of the World: A Global Priority*. Parthenon Publishing Group, New York and London.
22. Singh, P., M. Arora and N.K. Goel. 2005. *Effects of climate change on runoff of a glaciated Himalayan basin*. *Hydrological Processes*:20 (9): 1979-1992.
23. Dawa, S. & Humbert-Droz, B., (Eds.). 2003. *Ladakh Sub–State Biodiversity Strategy and Action Plan*. Prepared under the NBSAP-India.

Department of Environmental Science		
University of Ladakh		
Syllabus of M.Sc. Semester – IV (Core Course)		
Course Title: Environmental Biotechnology, Organic Farming & Social Issues	Course Code: PG-EVS-C4.2	
Credits: 04	Paper - II	Max. Marks: 100

Unit-I: Environmental Biotechnology

15 Hours

Specific Bioremediation Technologies: Land Farming, Biopiles, Composting, Bioventing, Biosparging, Pump And Treat Method, Phytoremediation; Remediation Of Degraded Ecosystems; Advantages And Disadvantages; Degradation Of Xenobiotics In Environment, Decay Behaviour And Degradative Plasmids, Hydrocarbons, Substituted Hydrocarbons, Oil Pollution, Surfactants, Pesticides, Heavy Metals Degradative Pathways. Integrated Pest Management; Development Of Stress Tolerant Plants, Biofuel; Mining And Metal Biotechnology. Microbial Transformation, Accumulation And Concentration Of Metals, Metal Leaching, Extraction; Exploitation Of Microbes In Copper And Uranium Extraction, Use Of Bioreactors For Bioremediation.

Unit-II: Environmental Microbiology

15 Hours

Microorganisms In Nature & Their Importance, Microbes In Service Of Nature & Mankind. Biogas Technology, Plant Design, Construction, Operation, Biogas From Organic Wastes, Microbiology Of Anaerobic Fermentation. Environmental Problems & Environmental Monitoring Through Microorganism, Microbiology Of Water, Air And Soil, Microbes As Pathological Agent In Plant, Animal And Man. Biotransformation, Bioconversion, Bioremediation. Genetically Modified Microbes & Their Uses In Environmental Management.

Unit-III: Organic Farming

15 Hours

Biopesticides: Introduction, Biological Insecticides, Properties Of Bacillus Thuringiensis, Microbial Pesticides, Entomopathogenic Fungi Or Viruses, Entomopathogenic Nematodes. Biochemical Pesticides Plant-Incorporated Protectants (Pips) Like GM Plants Etc., Insect Pheromones And Other Semi Chemicals, Applications Of Biopesticides. Biofertilizers: Classification, Nitrogen Fixation (Bacterial, With Blue Green Algae Etc.), Symbiotic Nitrogen Fixers Rhizobium Sp., Non-Symbiotic, Free Living Nitrogen Fixers Azotobacter, Azospirillum Etc. Phosphate Solubilizing Microorganisms (PSM) Bacillus Pseudomonas, Penicillium Aspergillus Etc. Mycorrhiza, Cellulolytic Microorganisms And Organic Fertilizers.

Unit-IV: Social Issues and the Environment

15 Hours

Unsustainable To Sustainable Development, Resettlement And Rehabilitation: Problems And Concerns, National Land Acquisition, Rehabilitation And Resettlement Act, 2013, Concept Of Environmental Movement, Genesis And Evolution Of Environmental Movements, Major Environmental Movements (Bishnoi Movement, Chipko, Appiko, Narmada Bachao, Tehri Dam Conflict, Silent Valley Movement, Nadi Bachao, Beej Bachao, Jungle Bachao, Gaon Bachao, The Conflict Over Limestone Quarrying In Doon Valley), Rehabilitation Of People Of Disaster Affected Areas.

Suggested Readings:

1. Kothari, C.R. Research Methodology – Methods and Techniques. 2nd revised ed. New Age International (P) Ltd. Publishers, New Delhi. 2007.
2. Pepper W. (1995). Environmental Microbiology. A.P. Publishers.
3. Powar C.B and Dagainwala H.F. (1985). General Microbiology, Vol. I &II, 2nd Ed., Himalaya Publishing House.
4. Michael J.Pelczar. (1994). Microbiology-Concepts and applications, McGraw-Hill Inc.
5. Ramesh Vijaya K. (2005). Environmental Microbiology. MGP Publishers, Chennai.
6. Chatterji A.K. (2005). Introduction to Environmental Biotechnology, Prentice-Hall of India Private Limited. New Delhi.
7. Wainwright, M. 1999. An Introduction to Environmental Biotechnology. Springer.

8. Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
9. Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley & Sons.
10. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
11. The complete book on Organic farming and Production of Organic compost (2008). Asia Pacific Business Press Inc.
12. R. K. Biswas, 2014. Organic Farming in India. N.D. Publishers, First Edition.
13. P.L. Maliwal, 2020. Principles of Organic farming. Scientific Publishers.
14. P.L. Maliwal, 2020. Practical Manual on Organic farming. Agri Biovet Press.