M. Sc. Environmental Sciences, Semester I

Course Code: EVS 170 **Maximum Marks: 100**
Course Title: Foundation Course on Environmental Biology and Ecosystem Dynamics **Internal Assessment Marks: 40**
University Examination Marks: 60
Credits: 04 **Duration of Exam: 3 hours**

Objectives

The goal of the course is to aid students in comprehending the fundamentals of ecology, the environment, and ecosystem dynamics and human interaction with nature.

Unit I: Concept and Scope of Ecology

1.1 Ecology: definition, history, scope and sub-divisions.
1.2 Role of ecology in sustainable development, concept of Human ecology and impact of human settlements.
1.3 Historical background of ecology, relevance of ecology to humankind, level of organization in ecology
1.4 Relationship of ecology with other branches of science, Branches of Ecology.

Unit II: Origin and Evolution of Biological Diversity

2.1 General classification of biological diversity (plants and animals); Growth and Morphogenesis in plants and animals.
2.2 Basics of photosynthesis, transpiration, biological nitrogen fixation, Physiological, biochemical and genetic mechanisms associated with adaptations of plants and animals.
2.3 Forest ecosystem - Forest as an ecosystem, distribution of forests, types of forests, economics and ecology of forest.
2.4. Role of forests in protection of species regulation of climate and production of various produce; Ecosystem Services: definition, concept, and importance.

Unit III: Ecosystem Concepts and Dynamics

3.1 Principle and concept of ecosystem, types of ecosystems
3.2 Biotic and abiotic components of ecosystem, biomes, ecotones and edge effect, ecological niche and equivalents, ecotype, ecophene and ecological indicator
3.3 Biogeochemical Cycle: Carbon, Nitrogen, Phosphorus and Sulphur and Hydrological cycles and their significance
3.4 Ecological pyramids of number, biomass and energy, food chain, food web and trophic levels, ecological amplitude and ecological niches; Ecological Succession.

Unit IV: Population and Community Dynamics

4.1. Characteristics of populations: size, density, dispersion, age, structure, natality and mortality; factors affecting population growth.
4.2. Theories of population growth: Inter and intra specific interactions: competition, coexistance, mutualism, commensalism and prey-predator interactions.
4.3. Genecology: ecological amplitude, ecads, ecotone, ecotypes, ecospecies, coenospecies, k–selection and r–selection populations.
4.4. Definition of community, its characteristics, diversity, dominance, structure, stratification, periodicity, fluctuation within community, Interdependence within community.

Unit V: Study of Different Ecosystems

5.1 Grassland ecosystem - Distribution and types of grasslands, rangelands and biodiversity in grassland, and productivity in grasslands
5.2 Desert Ecosystem and Wastelands-Desert as ecosystems, hot and cold deserts, productivity, characteristics and global distribution of deserts; Desertification process; Types and distribution of wastelands in India
5.3 Aquatic Ecosystem: Lentic and lotic ecosystem, structure, energy flow and productivity in estuaries, marine ecosystem, structure biodiversity and productivity in marine ecosystem
5.4 Wetland Ecosystem: Distribution, energetics and productivity in wetlands; economic importance of wetlands.

Course Outcomes:

1. The students will comprehend the various ecological layers of organization as well as the limiting elements regulating plant development and dispersal.
2. Students will gain an understanding of the traits of populations, meta populations, communities, and ecosystems.
3. Students will comprehend the dynamics of intra- and inter-specific interactions.
4. The course will help students gain a grasp of the kinds and functions of ecosystems.
5. Using ecological knowledge to advance the societal welfare

Note for the paper setter:

The question paper will have two sections. Section 'A' will carry 10 compulsory, objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section B will have 10 long answer type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. Chairs, D.D. (2014). Natural Resources Conservation. Pearson
2. Douglas, J. Futuyma (2006). Evolutionary Biology, (3rdEdition). Sinauer Associates.
3. Eldon, D., Enger, Bradley, Smith, F. and G. Smith (2008). Environmental Science: a study of interrelationship. Tata McGraw Hill.
4. Eugene P. Odum and Gary W. Barrett. (2018). Fundamental of Ecology 5th Edition Cengage Learning, India Pvt. Ltd., New Delhi.
5. Fath, B. (2019), Encyclopedia of Ecology, Vol 1-5, Elsevier Publishers, Netherlands.

6. Grant, W.E. and Swannack, T.M. (2008). Ecological Modelling. Blackwell.
7. Kormondy,E.J.(Ed.)(2017).Concepts of Ecology.PrenticeHall.
8. Miller, G.Tyler, Jr. (2005). Sustaining the Earth, 7th edition.Brooks/Cole-Thomson Learning, Pacific Groove, California.
9. Odum, E.P. (2005). Fundamentals of Ecology (5th Edn). Saunders and Com.
10. Wilkinson, D.M.(2007).Fundamental Processes in Ecology: An Earth System Approach. Oxford.
11. William, D.B, Sally D.H (2020) Ecology. Fifth edition, Oxford University Press, United Kingdom.
12. Kumar, P., and Mina U., (2018). Fundamentals of Ecology and Environment. Second Edition. Pathfinder Publication New Delhi, India.
13. Nachiketa, N.,(2021). Environment and Ecology: A Dynamic Approach. G.K Publications Pvt.Ltd.

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 171 **Maximum marks: 100**
Course Title: Environmental Chemistry **University Examination: 60**
Credits: 04 **Sessional Assessment: 40**
Duration of Exam: 3 hours

Objectives

In this course, students will delve into the chemicals shaping our environment, their interactions, and human-induced changes. Students will be able to understand the biochemical aspects, atmospheric chemistry, and learn analytical techniques for a comprehensive perspective.

Unit I: Fundamentals of Environmental Chemistry

1.1 Concept of elements: Chemical bonding, chemical reactions, mole concept; Solution Chemistry: solubility product, Solubility of gases.
1.2 Laws of thermodynamics- first, second and third, Stoichiometry, Gibbs energy, Chemical Potential, Chemical Equilibrium, Acid-base reactions
1.3 Free radical reactions, catalytic processes, elemental cycles (C, N, S, O) and their environmental significance.
1.4 Applications and management of isotopes and other radionuclides in the environment; sources of artificial and natural radiation.

Unit II: Atmospheric Chemistry

2.1 Structure and composition of atmosphere, Major and trace gases in the atmosphere, cycling of primary gaseous pollutants
2.2 Climate change and Global Warming, Greenhouse effect, major greenhouse gases, Residence time of greenhouse gases.
2.3 Tropospheric oxidation-reduction processes, smog formation; stratospheric and surface ozone, chlorofluorocarbons and their substitutes (HCFCs, HFCs).
2.4 Chemical speciation, particles, ions, and radicals in the atmosphere, role of hydrocarbons, oxides of sulphur and nitrogen, halogens in the atmosphere.

Unit III: Chemistry of Water

3.1 Water quality and wastewater treatment (primary, secondary, tertiary and quaternary).
3.2 Structure and properties of water, Water quality parameters, Concept of DO, BOD and COD.
3.3 Auto-ionization of water, Acid base equilibria, pH of water, redox reactions
3.4 Buffer solutions: concept of Buffering capacity, carbonate system in water.

Unit IV: Chemistry of Soil

4.1 Introduction to soil: Soil profile, Physio-chemical composition of the soil.
4.2 Inorganic and organic components of soil; concept of Humus, nutrients (NPK) in soil.
4.3 Significance of C: N ratio, Soil buffering, Cation exchange capacity (CEC) in soil.
4.4 Earth crust: general concept and Weathering Mechanism: Physical and Chemical.

Unit V: Environmental Biochemistry

5.1 Fundamentals of Biochemistry: Overview of Biomolecules, Structure and function of Macromolecules.
5.2. Cellular Biochemistry: Cellular Structure and Organization, Cellular Metabolism and Energy Transfer.
5.3 Proteins, Carbohydrates and Lipids: Structure, Function Metabolism (genera account).
5.4. Enzymes and Nucleic Acids: structure and catalysis, Role and function of nucleic acids in cellular processes.

Course Outcomes

1. *The goal of the course is to understand the foundations and importance of environmental chemistry.*
2. *Students will be able to describe how gaseous pollutants interact with the atmosphere.*
3. *Students will comprehend the concept of soil and water chemistry and its significance.*
4. *Students will comprehend the general process of soil formation and its chemical characteristics.*
5. *By exploring the basic ideas of environmental biochemistry, students will be able to decipher the complex interactions that exist between living things and their chemical environments.*
6. *This course will enable students to become acquainted with the various analytical techniques and related instrumentation.*

Note for the paper setter:

The question paper will have two sections. Section 'A' will carry 10 compulsory, objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section B will have 10 long answer type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1 Baird, C (2012). Environmental Chemistry. W. H. Freeman and Company, USA.
2 Banerjii, S.K. (2007). Environmental Chemistry. Prentice Hall of India Pvt. Ltd., New Delhi.
3 De, A. K. (2012). Environmental Chemistry. New Age International Ltd., New Delhi.
4 Girard, J. E. (2015). Principals of Environmental Chemistry. Jones and Bartlett Publishers, Inc.
5 Manahan, S. (2017). Environmental Chemistry. CRC Press.
6 Masters Gilbert M. (2015). Introduction to Environmental Engineering. Pearson Education, India
7 Mido, Y. and Satake, M. (2003). Chemicals in the environment. Discovery Pub. House, New Delhi.
8 Sharma, B. K. (2019). Environmental Chemistry. Krishna Prakashan Media Pvt. Ltd. Meerut.
9 Sodhi, G. S. (2006). Fundamental concepts of environmental chemistry. Narosa Publishing House, New Delhi.
10 Balwant (2023). ENVIRONMENTAL CHEMISTRY (3rd Edition.). PragatiPrakashan, India.
11 Freeman W. H.. and James G. (2019). Principles of Environmental Chemistry (2nd Edition). Jones & Bartlett Learning.

12 De, A. K., (2018). Environmental Chemistry. (9th edition). New Age International Publishers, India.

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 172
Course Title: Environmental Pollution
Credits: 04

Maximum marks: 100
University Examination: 60
Sessional Assessment: 40
Duration of Exam: 3 hours

Objectives

This course has been designed to improve the familiarity of the students about different problems related to various kinds of pollution (i.e. air, water, soil and noise), their monitoring and the control strategies. Issues related to thermal and radioactive pollution and their impact on environment and health are also dealt with in this course.

Unit I: Environmental Monitoring

1.1 Environmental monitoring: An introduction and objectives.
1.2 Global environmental monitoring system (GEMS): importance and relevance.
1.3 National environmental Monitoring Programmes: salient features.
1.4 Bioindicators and biological monitoring system.

Unit II: Air pollution

2.1 Sources of air pollution, Ambient air quality standards; Effects of pollutant on human health, plants and animals
2.2 General methods for control of Gaseous and particulate pollutants: Adsorption, Absorption, Oxidation, Desulphurization, Scrubbers, Condensers, Settling chambers.
2.3 Control equipment for particulate matter: gravity settling chambers, cyclone separator, electrostatic precipitators, Filters: Fabric filters, Bag House filter, Hybrid filters.
2.4 Method of Monitoring of Sox, Nox, Co, Pm_{25}, Pm_{10}, Indoor air Pollution (Smoke, hydrocarbons, particulate matter, radon).

Unit III: Water Pollution

3.1 Major sources of water pollution, Water quality indices, Water quality standards (National and International); Marine water pollution.
3.2 Effects of Water pollution on human health, plants, aquatic life and environment.
3.3 Water Pollution control technologies: Sewage and waste water treatments systems. Sewage and wastewater treatment and recycling, Industrial effluent treatment
3.4 Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Biofilms in treatment of waste water.

Unit IV: Soil and Noise Pollution

4.1 Sources of soil pollution; Effects and consequences of soil pollution on microbes, plants and animals; Control methods.
4.2 Physico - chemical and biological sampling and analysis of soil quality; Interaction of soil pollutants with soil components; Soil reclamation strategies.
4.3 Sources of noise pollution: indoor and outdoor noise pollution; Measurement of

noise, exposure levels and Standards.

4.4 Impact of noise on human health; Control strategies for Noise and abatement measures.

Unit V: Radioactive and thermal pollution

5.1 Radioactive pollution: types, sources and consequences; half-life period, natural radiation.

5.2 Radioactive waste management and Radioactive fallout.

5.3 Case study: Chernobyl Accident: Three mile island accident, Fukushima radio-active leakage.

5.4 Thermal and nuclear power plants as sources of thermal pollution. Effects of thermal pollution on aquatic flora and fauna; Control measures of thermal pollution.

Course Outcomes:

1. *To provide theoretical and practical knowledge on different aspects of pollution to the students.*
2. *To develop understanding about the different sources of air, water, soil, noise and thermal pollution.*
3. *To impart knowledge on the various environmental monitoring techniques available to monitor the varying levels of pollutants in the environment.*
4. *To understand the significance of various control measures of pollution.*
5. *Ability to develop pollution mitigation/abatement strategies.*
6. *To realize the critical issues of handling pollution vis a vis human beings.*
7. *To develop the analytical ability to link cause and effect of pollution which will make them more aware in future.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 10 compulsory, objective-cum-short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 10 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. A. K. De (2001). Environmental Chemistry, New Age International Publishers, New Delhi.
2. Andrew D. Eaton, Lenore S. Glesceri, Eugene W. Rice and Arnold E. Greenberg (Eds) (2005). Standards Methods for the Examination of Water and Wastewater Analysis. 21st Edition, APHA, Washington DC.
3. Dara S. S, (1998). A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd, New Delhi.
4. Davis, M. L. & Cornwell, D.A. (2012). Introduction to Environmental Engineering McGraw Hill International Edition.
5. El –Nemr, A. (2010). Impact, monitoring and Management of environmental pollution. Nova Science publishers Inc., New York.
6. F. W. Fifield (2000). Environmental Analytical Chemistry. 2nd edition, Blackwell Publishers.

7. Hill,M.K.(2010).Understandingenvironmentalpollution.CambridgeUniversityPress.

Howard S Peavy (2003). Environmental Engineering, Tata Mc Graw Hill Publishing Company Ltd., New Delhi.

8. Julian E Andrews et al., (2004). An Introduction to Environmental Chemistry, Blackwell Publishing.
9. Khopkar, S. M.(2018). Environmental pollution and monitoring. New Age international Pvt. Limited.
10. S. E. Manahan (2009). Fundamentals of Environmental Chemistry, CRC Press, USA.
11. Sawyer C.N., Mc Carty P. L., and Parkin, G. F (2003). Chemistry for Environmental Engineering and Science, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
12. Stanley E. Manahan (2010). Environmental Chemistry, 9th Edition, CRC Press, London.
13. Sethi et al., (2022). Environmental Pollution Causes Effects and Control. Common Wealth Publisher, India.
14. Verma, O., Shanker, R., (2023). Environmental Pollution. First Edition.New Age International Private Limited, India.

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 173 **Maximum Marks: 50**
Course Title: Concepts of Earth Sciences **Internal Assessment Marks: 20**
University Examination Marks: 30
Credits: 02 **Duration of Exam: 2 hours**

Objectives

Course will help to understand the structure of Earth and various geo-morphological processes as well as formation and modification of landforms on the Earth.

Unit I: Interior of Earth

1.1 Types of seismic waves and their role in the study of Earth's interior.

1.2 Different zones in the Earth's interior and their composition.

1.3 The Earth's Magnetic Field - Magnetic reversal and magnetic anomaly.

1.4 Continental Drift Theory and Theory of isostasy and global isostatic adjustment.

Unit II: Geo-morphological Processes

2.1 Types of sedimentary and igneous rocks. Metamorphic rocks and their types; Rock cycle

2.3 Folds and faults, major types of folds and faults

2.4 Physical weathering, chemical weathering and their types.

2.5 Volcanism - Components and types of volcanoes, volcanic materials, process and effects of volcanism

Unit III: Geo-morphological Systems

3.1 Factors affecting landform development.

3.2 Fluvial system - Factors affecting stream erosion and deposition, erosional and depositional landforms.

3.3 Underground water system - Water table, landforms formed by ground water action.

3.4 Aeolian system and Glacial System - Mechanism of wind erosion, erosional and depositional landforms.

Course Outcomes:

1. *Students will be able to develop an understanding towards various zones in the interior of the Earth and its composition.*
2. *Students will get an idea about the geo-morphological process.*

3. *Students will realize the formation and modification of landforms on the Earth.*
4. *Factors affecting the development of landforms will be understood by the students*

Note for Paper Setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Thornbury, W.D. (2004). Principles of Geomorphology. New Ages International Publishers.
2. Keller, E.A. (2012). Introduction to Environmental Geology (5^{th} Eds). Prentice Hall, New Jersey.
3. Press, F. and Siever. R. (2003) .Understanding Earth (4^{th} Eds). W.H. Freeman & Co., U.S.A.
4. Singh, S. (2000). Physical Geography.Prayag Pustak Bhawan, Allahabad.
5. Smithson, P.; Addison, K. and Atkinson, K. (2002).Fundamentals of the Physical Environment . Routledge Publishers, London.
6. Strahler, A.H. and Strahler, A.N. (2008). Modern Physical Geography. John Wiley & Sons, New York
7. Ritter, D.F.; Kochel, R.C.and Miller, J.R. (2016).Process Geomorphology. Wm. C. Brown Publishers, U.S.A.
8. Cooke, R.U. and Doornkamp, J.C. (1990). Geomorphology in Environmental Management- An Introduction (2^{nd} Eds), Clarendon Press, Oxford, U.K.

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 174 **Maximum marks: 50**
Course Title: Environmental Disasters: Management and Mitigation **University Examination: 30**
Sessional Assessment: 20
Duration of Exam: 2 hours

Objectives

The goal of this course is to acquaint students with the many kinds of catastrophes and how they are managed. The training will improve the students' information, knowledge, and skills, enabling them to respond appropriately both before and after a crisis.

Unit I: Disaster: an introduction

1.1 Disasters: concept, definition, difference between disaster and hazard.
1.2 Disaster management cycle: concept and role.
1.3 Man- Made Disasters: introduction, types, general effects and concerns.
1.4 Biological disasters: meaning, types, vulnerability, effects, preparedness and mitigation.

Unit II: Disaster: Types and Effects

2.1 Causes and Management of Manmade Disasters: Nuclear Disaster; Chemical Disaster and Fires.
2.2 Characteristics, causes, prediction and warning of Natural Disasters: Earthquake and Tsunamis.
2.3 General Characteristics, Causes, Vulnerability and Effects of Landslides, Snow Avalanches and Volcano.
2.4 General Characteristics, Vulnerability, Effects, Forecasting & Warning of Cyclone, Floods and Drought.

Unit III: Disaster: Response, Mitigation and Management

3.1 Disaster response plans: Search, Rescue and evacuation; Risk and Vulnerability; Risk analysis techniques, vulnerability identification and factors associated with vulnerability.
3.2 Disaster preparedness: Concept and nature, Disaster preparedness plans, Role of Information, education, communication, & awareness.
3.3 Disaster mitigation: principles, mitigation approaches and strategies.
3.4 Recovery: Rehabilitation, its social and economic aspects, Housing to resist disasters, relocation, retrofitting, repairing and strengthening of houses.

Course Outcomes:

1. The concept of numerous natural catastrophes and risks will be understood by the students.
2. Learners will be able to comprehend the many causes of both natural and man-made disasters.
3. Knowledge of the plans for responding to disasters will be gained.
4. Students will comprehend methods and techniques for disaster mitigation.
5. Students will comprehend the process of therapy and recovery.

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Bryant, E. (2005). Natural Hazards. Cambridge University Press, Cambridge, New York.
2. Carter, W. N. (2008). Disaster Management: A Disaster manager's handbook. ADB Publication, Manila.
3. Cutter, S.J.(2006). Hazards vulnerability and environmental justice (earth scan risk in society) Routledge.
4. Pal, I. and Ghosh, T. (2017). Natural Hazards Management in Asia. SAGE Publishing House.
5. Smith, K. (2013). Environmental Hazards, Assessing risk & Reducing disaster, London.
6. Lee, D. (2010). Encyclopedia of Natural Disasters. Viva Books.
7. Sharma, S.C. (2022). Disaster management, Second Edition, Khanna Publishing House.

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 190 **Maximum marks: 100**
Course Title: Based on EVS 171 and EVS 173 **University Examination: 50**
Credits: 04 **Sessional Assessment: 50**
Duration of Exam: 3 hours

1. Find out the amount of CO_2 in water sample by Titration method.
2. Find out the amount of DO from water sample by Alsterberg's alkaline sodium azide method.
3. Find out the amount of Cl in water sample by Titration method.
4. Find out the amount of CO_3 and HCO_3 from given water sample by Titration method.
5. Find out the amount of Ca++ and Mg++ from given water sample by Titration method.
6. Find out pH of given water sample by potentiometric method.
7. Study the temperature variations in lotic and lentic water bodies at different depths.
8. Find out the transparency of water by Secchi Disc method.
9. Analyze the water sample for amount of TDS.
10. Analyze the water sample for amount of TSS.
11. Analyze the water sample for amount of TS.
12. Find out the electrical conductivity of given water sample.
13. Study the Texture of different types of soils of surrounding areas.
14. Determine the Bulk density and porosity of the soil.
15. Study the different types of rocks of Pir Panjal Biodiversity Park.
16. Estimate the temperature & moisture contents of the different soil at different profile- (surface: 10cm, 20cm, and 30cm).

M. Sc. Environmental Sciences, Semester I

Course Code: EVS 191 **Maximum marks: 100**
Course Title: Based on EVS 172 and EVS 174 **University Examination: 50**
Credits: 04 **Sessional Assessment: 50**
Duration of Exam: 3 hours

1. Study the principle, construction and working of high volume air sampler.
2. Determine the suspended particulate matter load in the ambient air.
3. Determine the indoor particulate matter using handy air sampler.
4. Measure the SO_2 and NO_2 concentration in air.
5. Measure the leaf area and length; breadth values of different species collected from polluted and non polluted sites (e.g. monocots &; dicots) and to compute the Kemp's Constant for each species.
6. Calculate the Stomatal Index on the upper and lower surface of given leaf material.
7. Calculate the Stomatal Frequency on the upper and lower surface of given leaf material.
8. Different methods for the collection of municipal solid waste and its disposal in your community.
9. Determine the BOD of a water sample from a given water body.
10. Find out the COD of the water sample by open reflux method.
11. Analyse the amount of nitrates from given water sample.
12. Analyse the amount of phosphates from given water sample.
13. Analyse the amount of sulphates from given water sample.
14. Analyse the amount of silicates from given water sample.
15. Analyse the physico-chemical properties of soil samples collected from different polluted and unpolluted sites.
16. Volumetric analysis of different soil samples by EDTA titration.
17. Prepare a questionnaire to study the social impacts of natural hazards.
18. A field visit for the preliminary assessment to assess various types of natural hazards in different parts of the Jammu and Kashmir.

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 270
Course Title: Climate Science
Credits: 04

Maximum Marks: 100
Internal Assessment Marks: 40
University Examination Marks: 60
Duration of Exam: 3 hours

Objectives

The paper deals with dynamics of atmospheric processes which has led to global climate change. The paper also explores effects of global changes on human communities and initiatives taken at global and regional levels to combat them.

Unit I: Climate Change: An introduction

1.1 Concept of weather and climate; Drivers of Earth's climate system; Energy and material balance.
1.2 Milankovitch cycles; energy transfers in atmosphere; Earth's radiation budget.
1.3 Introduction to the Climate System; Earth's climate through ages; Introduction to climate models.
1.4 Climate change in the present and future – trends and causes; Learning from the Past.

Unit II: Climate Change: Impacts

2.1 Impacts of climate change on Agriculture, forestry, water resources and biological responses: range shift of species.
2.2 Effects of climate change on oceans: El Nino and La Nina; Impact on economy and biodiversity
2.3.Impacts on Society, marginalized sections, displacement and migration, human settlement and health.
2.4 Global warming, Glaciers & sea levels, Extreme events, ozone hole, atmospheric brown clouds.

Unit III: Responses to Climate Change: Vulnerability, Adaptation and Mitigation

3.1 Concept of Vulnerability and Risk assessment.
3.2 Climate change adaptation – sectors, elements, Costs and benefits.
3.3 Adaptation concepts and strategies: a global perspective.
3.4 Climate change mitigation – global measures, agreements and framework.

Unit IV: Policy Framework on Aspects of Climate Change

4.1 International Efforts in combating climate Change: The United Nations Framework Convention on Climate Change (UNFCCC).
4.2 India's Initial National Communication (NATCOM) to United Nations Framework Convention on Climate Change
4.3The Kyoto Protocol to the Framework Convention; Paris Agreement, Role of the IPCC on Climate Change; Ecological Footprints and Carbon Footprints.
4.4Carbon credit and Carbon trading; clean development mechanism (CDM), International Emission Trading (IET), Joint Implementation (JI).

Unit V: Climate Change and India's Concerns

5.1 Climate Change Impacts on Natural Resources; Vulnerability of Coastal Belt in India towards climate Change.
5.2 Climate Change, Rural Livelihoods and Food Security in India; UNDP in India addressing climate change
5.3 India's Position on International Climate Negotiations; Role of MoEFCC & other National Agencies.
5.4 India's Perception to Climate Change-India's National Action Plan on Climate Change (Eight Mission).

Course Outcomes:

1. *To impart knowledge to the students about the science behind global climate change.*
2. *The students are made to understand the reasons for concerns to climate change impacts.*
3. *The course will enable students to understand the impact of climate change on the environment as whole.*
4. *To identify and understand the related adaption and mitigation strategies.*
5. *The students will be able to learn various National and International strategies to combat climate change and related issues.*

Note for the paper setter:

The question paper will have two sections. Section 'A' will carry 10 compulsory, objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section B will have 10 long answer type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. Cunningham,W.P. and Saigo,B.W.(1999). Environmental Science - A Global Concern WCB MCGraw- Hill, U.S.A.
2. Emiliani, C. (1992). Planet Earth.Cambridge University Press,U.K.
3. Fellmann,J.;Getis,A. and Getis,J.(1996).Human Geography-Landscapes of Human activities. WCB McGraw- Hill, USA.
4. Houghton, J. (1997).Global Warming - The complete Briefing.Cambridge Univ. Press, U.K.
5. Lean,G. & Hinrichsen,D.(1994). Atlas of the Environment. Harper Perennial Pub., New York.
6. Lundgren, L. (1986). Environmental Geology, Prentice Hall, New Jersey.
7. Lunine, J.I. (1999).Earth-Evolution of a Habitable World.Cambridge Univ. Press, U.K.
8. McKnight, T.L. (1993).Physical Geography-A Landscape Appreciation.Prentice Hall, New Jersey.
9. Pearce,F. (1989). Climate and Man - From the Ice Ages to the Global Greenhouse. Ivision Books, London.
10. Rogers, J.J.W. and Feiss, P.G. (1998). People and the Earth - Basic Issues in the Sustainability of Resources and Environment. Cambridge University. Press, U.K.
11. Smithson, P.; Addison,K. and Atkinson,K. (2002). Fundamentals of the Physical Environment. Routledge Publishers, London.
12. Wellburn,A.(1996).Air Pollution and Climate Change-The Biological Impact. Longman Publishers, Singapore.
13. Agrahari, R. P., (2023). Environmental Ecology, Biodiversity, Climate Change & Disaster Management (3rd Edition.). McGraw Hill; Standard Edition. India.

14. Singh, A. K., (2023). Global Warming and Climate Change: Story of India's Climate Disaster and How to Avoid it. Notion Press Media Pvt Ltd.
15. Vibhaw, N., (2020). Environment, Energy and Climate Change (1st Edition.). Generic.
16. Tandon, U., (2015). Climate Change: Law, Policy and Governance. Eastern Book Co. (EBC). India.

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 271 **Maximum Marks: 50**
Course Title: Natural Resources and Energy Management **Internal Assessment Marks: 20**
University Examination Marks: 30
Credits: 02 **Duration of Exam: 2 hours**

Objectives

The course is designed to provide information to the students about the natural resources of this planet, the causes of their depletion & their conservation & management for future use.

Unit I : Natural Resources - Plants & Animals

1.1 Natural resources: introduction, characteristics & classification.
1.2 Plants as a natural resource: a general account with reference to timber, food fodder, & fiber.
1.3 Animals as a natural resources: a general account with reference to edible species of aquatic animals, insects and earth worms aquatic invertebrates, prawn, lobster, mollusks and crabs; shell fish prawn
1.4 Pharmaceuticals from plants and animals (general idea).

Unit II : Natural Resources - Soil, Minerals and Energy

2.1 Soil as a natural resource: a general account with reference to nutrients and soil biota
2.2 Origin, distribution & uses of economic minerals with special reference to India and its impact.
2.3 Energy (Coal, oil & natural gas), Hydro Energy, Wind Energy, Tidal Energy (brief account)
2.4 Solar energy, Nuclear energy, Biogas, fire wood , Petro-plants, Dendro thermal energy (brief account)

Unit III: Natural Resources- Conservation Strategies & Management

3.1 *Ex-situ* and *In-situ* conservation of Plants & Animals
3.2 Soil Conservation: concept, approaches and measures
3.3 Conservation & Management of Water Resources
3.4 Conservation & Management of Energy resources

Course Outcomes:

1. *Paper provides basic concepts on the natural resources.*
2. *It familiarizes students about different types of natural resources and their interaction with surroundings.*
3. *It helps student in developing abilities to understand the fascinating aspects of natural resources and their importance.*
4. *Increases interest of students to understand conservation strategies and management of natural resources.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Apps, J.M and Price, David (2012). Forest Ecosystems, Forest Management and the Global Carbon Cycle (Nato ASI Subseries I:)
2. Brady, N.C. and Weil, R.R. (2008). The nature & properties of soil (14th Eds). Person
3. Jadhav,H.V. and Purohit, S.H. (2008). Environmental Management. Himalaya Publishing House. Delhi.
4. Jabde V. Pradip. (2005): Text book of Applied Zoology, 1st Edition, Discovery Publishing House, New Delhi.
5. Malhotra P. (2008): Economic Zoology, 5th Edition, Adhyayan Publishers, New Delhi.
6. Shukla G.S. and Upadhay (2001): Economic Zoology, 4th Edition, Rastogi Publications, Meerut.
7. Singh,M.P.(2004). Natural Resources & renewable Energy. Daya Publishing House,Delhi.
8. Dar,G.H., Bhagat,R.C., Khan,M.A.(2002). Biodiversity of the Kashmir Himalaya. Anmol Publication, Pvt. Ltd. New Delhi.
9. Singh, B.P. and Srivastava, U. (2013). Plant genetic resources Indian prespectives. ICAR Publication, New Delhi.
10. Forest Research Institute (2002). The Development of India's Forest Resources. Dehradun.
11. Gautam, A. and Rastogi, S. (2003). Resource Geography. International Publishing House,Meerut
12. Gupta, K.C. (2002). Energy & Environment in India - A study of Energy Management. Gyan Publishing House, New Delhi.
13. Ghosh, A.K. (2002). Lesser Known Animal Resources of India. Zoological Survey of India. XI-XXVII.

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 272 **Maximum marks: 50**
Course Title: Ecotoxicology **University Examination:30**
Credits: 02 **Sessional Assessment: 20**
Duration of Exam: 2 hours

Objectives

The course deals with various aspects of environmental toxicology from molecular to ecosystem level so as to equip students to evolve best ways of dealing with chemical pollution.

Unit I: Ecotoxicology: Concept and historical background

1.1 Principles and mechanism of toxicity; Development of environmental toxicology - Historical and evolutionary perspective.
1.2 Toxicants and Toxicity - factors effecting toxicity; toxicants in the environment.
1.3 Toxicity of chemical mixtures.
1.4 Dose effect and response; Dose-response relationships.

Unit II::**Routes and kinetics of toxicant uptake**

2.1 Toxicity testing: Testing for acute toxicity and chronic toxicity; Toxico Kinetics – Absorption, Distribution and elimination of toxicants.
2.2 Route of toxicant uptake - skin, lungs, GIT, gills, toxicant uptaken in plants.
2.3 Biochemical effects of Mercury, Lead, Chromium, Cadmium, Arsenic and their relation to toxicity; mutagens and immunotoxic agents.
2.4. A general account of Biotransformation, bioaccumulation and biomagnification.

Unit III: **Complex issues in Toxiology**

3.1. Antidotal procedure in toxicology; Environmental Toxicology of metal mining and Smelting.
3.2. Environmental toxicology of fertilizers; ecotoxicology of herbicides.
3.3. Biological indicator of toxicants; Methodology of ecological reassessment and risk management.
3.4. Environmental toxicants and human health – role of FAO, WHO and EPA.

Course Outcomes:

1. *The course is designed to know the concept and historical background of ecotoxicology.*
2. *Students will be able to explain various toxicity methods and kinetics of toxicants uptake.*
3. *General process of ecotoxicology will be understood by the students.*
4. *Students will be able to understand the complex issues of toxicology and role of international organizations.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Banerjii, S.K. (2007). Environmental Chemistry. Prentice Hall of India Pvt. Ltd., New Delhi.
2. De, A.K. (2007) Environmental Chemistry, New Age Int. Lts. N. Delhi.
3. Greenberg, M. I. (2003). Occupational, Industrial and environmental toxicology. Mosby Incl.
4. Srujana, K. (2021). Environmental Toxicology. Notion Press, India.
5. Raj, G. M. and Ravvendran, R. (2019). Introduction to basics of Pharmacology and Toxicology. Springer Singapore.
6. Sood, A.(1999). Toxicology, Sampand Songs, New Delhi.
7. Wright, D.A. &Welbowin, P. (2002). Environmental Toxicology, Cambridge Univ. Press, U.K.
8. Walker C.H. , Sibly, R.M., Hopkin S.P. Peakall D.B., (2012). Principles of ecotoxicology. CRC Press.
9. Macheal C. Newman. (2019). Fundamentals of ecotoxicology. CRC Press

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 273 **Maximum marks: 50**
Course Title: Environmental Economics **University Examination: 30**
Credits: 02 **Sessional Assessment: 20**
Duration of Exam: 2 hours

Objectives

This course is designed to make the students aware about the causes and consequences of economic growth in relation to the environment.

Unit I Environmental economics and environmental valuation

1.1 Environmental economics: introduction, concept and scope.
1.2 Market failure and Externalities: concept and an overview.
1.3 Environmental valuation: concept, need and methods
1.4 An introduction to Valuation methods: Hedonic pricing method and travel cost method.

Unit II Natural resources management; Economics and sustainable development

2.1 Exhaustible natural resources: concept need and economics
2.2 Sustainable Development: introduction, concept and indicators of relation with SDGS.
2.3 Environmental accounting for sustainable development: concept, need and importance
2.4 Environmentally corrected GDP; An introduction (brief account)

Unit III Development *viz a viz* Environment

3.1 Linkages between population, poverty and environment.
3.2 Common property resources & people's participation in their management.
3.3 Economic instruments for sustainable environmental management, (property rights, market creation, fiscal instruments and charge system)
3.4 Environmental Policy; National Environment Policy 2006; Clean development mechanism and carbon trading to combat Global Climate Change

Course Outcomes:

1. *Students will develop thorough knowledge on Environmental Economics and its valuation.*
2. *Range of economics of natural resource management in relation to sustainable development will be known to the students.*
3. *Students will be having the idea of common property resources and their management.*
4. *National Environmental Policy in relation to carbon trading and global climate change will be known to the students.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Gilpin, A. (2008). Environmental Economics: A Critical Overview, John Wiley & Sons Ltd., New York.
2. Hanley, Nick & Colin J.R. (2002).Issues in Environmental Economics.Blackwell Pub. Ltd.
3. Kolstad, C.D. (2016). Environmental Economics, Oxford University Press, New Delhi.
4. Lin, B. C. and Zheng, S. (2017). Environmental Economics and sustainability. Wiley Blackwell.
5. Smith, S. (2011). Environmental Economics: a very short introduction. Oxford University Press.
6. Subhasini, M. (2015). Economics of Environment. PHI Learning Pvt Limited.
7. Hussain Ahmed M., (2013). Principles of environmental economics and sustainability: an integrated economic and ecological approach (3rd edition), London: Routledge.
8. Lewis, L., & Tietenberg, T. (2019). *Environmental economics and policy*. Routledge.

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 274 **Maximum marks: 50**
Course Title: Analytical Methods in Environmental Science **University Examination: 30**
Credits: 02 **Sessional Assessment: 20**

Objectives

Course is designed to impart comprehensive knowledge to students about different analytical techniques their analysis, and related methodologies.

Unit I: Separation Techniques: Concepts and Importance

1.1 Mechanical Separation Techniques: Overview of filtration and sieving methods; Centrifugation and Sedimentation: Principles of centrifugation and sedimentation
1.2 Thermal Separation Techniques: Basics of distillation processes, Fractional distillation principles and applications.
1.3 Chemical and Biological Separation Techniques: Principles of chromatography and electrophoresis, Variations in techniques and their applications.
1.4 Overview of precipitation and leaching processes, principles of reverse osmosis and dialysis, Advanced Techniques - Magnetic Separation, Sublimation, and Zone Refining (brief account).

Unit II: Sample Preparation and Extraction

2.1 Concept and importance: Understanding the significance of sample preparation, Key concepts in sample preparation techniques.
2.2 Modern Extraction Techniques: Principles and applications of pressurized liquid extraction, Introduction to subcritical hot-water extraction, Comparative analysis of the two techniques.
2.3 Innovative Extraction Approaches: QuEChERS Approach of Extraction, Applications in pesticide residue analysis.
2.4 Specialized Extraction Techniques: Principles of membrane extraction, Applications in environmental and biological analysis, Liquid-liquid extraction: Basics and real-world applications.

Unit 3: Analytical Techniques and Instrumentation

3.1 Spectrophotometry: application and working principle of Spectrophotometer, Flame Photometer, Atomic absorption spectrophotometer (AAS) (general account)
3.2 Chromatography: principle and working of Gas Chromatography, High Performance Liquid Chromatograph (HPLC) (general account)
3.3 Principle and working of X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) (general account)
3.4 Principle and working of Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) (general account)

Course Outcomes:

1. *Students will develop a comprehensive understanding of various analytical techniques and their application.*

2. *Through the course, students will develop a broader perspective on analytical methods, gaining the ability to critically evaluate and select appropriate techniques for specific analytical tasks.*
3. *They will also be able to apply their knowledge to real-world scenarios, fostering problem-solving skills in the field of analytical chemistry.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Christian G. D. (2007). Analytical Chemistry, 6th Ed, John Wiley & Sons.
2. Willard H. H. (1981). Instrumental methods of analysis, Van Nostrand.
3. Marczenko Z. and Balcerzak M. (2000). Separation, preconcentration and spectrophotometry in Inorganic Analysis, Elsevier.
4. Katz E. (2009). Quantitative Analysis: Using Chromatographic Techniques, John Wiley & amp; Sons.
5. Rydberg J., Cox M. and Musikas C. (2004). Solvent extraction principles and practice, CRC Press.
6. Nath, S. K., (2022). Analytical Techniques in Plant Sciences (1st Edition). Mahaveer Publications, India.
7. De, A. K., (2018). Environmental Chemistry (9th edition). New Age International Publishers, India.

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 290 **Maximum marks: 100**
Course Title: Based on EVS 270 and EVS 274 **University Examination: 50**
Credits: 04 **Sessional Assessment: 50**
Duration of Exam: 3 hours

1. Study the economically Important Plant species of Pir Panjal Biodiversity Park.
2. Study the wild relatives of different plants available in the Campus.
3. Exploration, collection and identification of a few economically important animal taxa. *Meloidogyne incognita* (Nematode), *Periplanata americana* (Cockroach), *Schizothorax richardsonii* (Fish), *Apis dorsata* (Hony bee), *Coccinella septempunctata* (Ladybug)
4. Study the body structure of worker honey bee (*Apis mallifera*) and bee hives.
5. To check the purity of honey by using household techniques.
6. Collect, describe, identify and classify wild bioresources, including wild relatives of *Gallus* sp. *Canis* sp, *Capra* sp., *Equus* sp. *Bubalus* sp.
7. Study the structure of different types of wool (Pashmina, Sheep).
8. Demonstrate the principles of filtration and different chromatography techniques.
9. Familiarize students with High-Performance Liquid Chromatography (HPLC) techniques.
10. Introduce students to mass spectrometry principles and analysis.
11. Understand the application and working principle of spectrophotometer, flame photometer.
12. Understand the application and working principle of Atomic Absorption Spectrophotometer (AAS).

M. Sc. Environmental Sciences, Semester II

Course Code: EVS 291 **Maximum marks: 100**
Course Title: based on EVS 271 and EVS 272 **University Examination: 50**
Credits: 04 **Sessional Assessment: 50**
Duration of Exam: 3 hours

1. Study various case studies showing impact of climate change with special reference to Himalaya.
2. Study Global Climate variability and climate change.
3. Draw Ombrothermic curve from given data of Temperature and Precipitation.
4. Measurement of air temp. and related calculations.
5. Measurement of wind speed and direction.
6. Decoding of synoptic elements plotted on a weather map.
7. Study of various meteorological parameters (Air temp., humidity, rainfall, wind direction & speed) using Autoweather station.
8. Study the effect of penicillin on bacterial growth.
9. Preparation of analytical standard solutions using serial dilution method.
10. Find out the minimum and maximum sound pressure level and Leq10 in your classroom using sound level meter.
11. Study the effect of different concentrations of salt solution on Osmotic stress in onion.
12. From given data of % age mortality calculate Leq50.
13. From given toxicity data of chemical A & B calculate the Leq50 of mixture to conclude additional or antagonistic effect.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 370 **Maximum Marks: 100**
Course Title: Solid and Hazardous Waste Management **Sessional Assessment: 40**
University Examination: 60
Credits: 04 **Duration of Exam: 3 hours**

To acquaint the students with the common municipal solid wastes, their characteristic and the chaos caused by these wastes in the environment and to study the latest technologies to dispose of such wastes. Further it helps the students to understand the difference in perception of hazardous and biomedical wastes management, applications and their limitations.

Unit I: Introduction to Solid Waste

1.1 Sources and Types of solid wastes, Municipal solid waste, Industrial solid wastes and Hazardous wastes.
1.2. Present scenarios of municipal and industrial waste management in India.
1.3 Physical and chemical composition of municipal solid wastes, waste generation rates, factors effecting waste generation rates.
1.4 Prevalent SWM practices and deficiencies: Storage of waste at source, segregation of wastes, Primary collection of waste, transportation of waste, disposal of wastes, institutional deficiencies.

Unit II: Hospital and Pharmaceutical Waste

2.1. Definition and classification of hazards: Source of Hazardous Waste generation.
2.2. Role and Consequences of Hazardous Waste on human Health.
2.3. Technologies related to Hazardous Waste Management.
2.4. Treatment Technologies, Land disposal, Biomedical Waste & its Management.

Unit III: Handling, Separation, Storage and Processing of Solid Waste

3.1 Handling and separation of solid waste At site, Material separation by pick in, screens, float and separator magnets and electromechanical separator and other latest devices for material separation.
3.2 Waste handling and separation at Commercial and Industrial facilities.
3.3 Storage of solid waste at the sources; processing of solid waste at residence e.g. Storage, Conveying, Compacting, Shredding, Pulping, Granulating etc.
3.4 Processing of solid waste at Commercial and industrial site

Unit IV: Integrated solid waste management

4.1. Treatment and disposal techniques - Burning, Open dumping, landfilling.
4.2. Landfill emissions: Leachate and Landfill gas. Leachate collection & analysis. Landfill gas management. Their environment and health impacts.
4.3. Composting, Vermi-composting, Incineration Energy from Waste: Pyrolysis, Gasification, Biogas.
4.4. Waste disposal methods: Merits and demerits.

Unit V: Waste Minimization technologies and Prevention Laws

5.1 Concept of Reuse/recycling of different types of waste
5.2 Techniques for recovery of metals from waste: chemical, biological and hybrid techniques
5.3 Minimization of hazardous/toxic waste, production of biodegradable materials, concept of green technologies
5.4 Hazardous wastes (Management, Handling and Transportation) Rules, 2008, and amendments, Biomedical waste management rule, 2016 and amendments

Course Outcomes:

1. *Student will Identify the different sources of solid waste*
2. *Understand to execute the relevant method of collection and transportation of solid waste*
3. *Understand to execute an action plan for disposal of solid waste.*
4. *Students will understand to implement the relevant method of disposal of bio-medical waste.*
5. *Students will understand to implement the relevant method for disposal of industrial wastes and E- waste and lean about the relevant laws related to management of solid and hazardous waste.*

Note for the paper setter:

The question paper will have two sections. Section 'A' will carry 10 compulsory, objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section B will have 10 long answer type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. Sunita J. Varjani, Edgard Gnansounou, Baskar Gurunathan, Deepak Pant, Zainul Akmar Zakaria (2017). Waste Bioremediation. Springer.
2. Chandrappa, R.,and Brown, Jeff (2012).Solid Waste Management: Principles and Practice. Springer
3. John Pichtel (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, (2nd Eds.). CRC Press.
4. Vasudevan, R. Siddiqui Faisal Zia, Agrawal Sanjeev (2016). Solid And Liquid Waste Management Waste To Wealth.PHI Learning Pvt Ltd.
5. Ramachandra, T.V. (2009). Management of Municipal Solid Waste. TERI Publications.
6. Pant, D. (2010). Electronic Waste Management Lambart Aademic Publishing .
7. Pant, D. (2011). Pharmaceutical Waste Management Lambart Academic Publishing.
8. Harrison, M. Roy (ed.) (2001) Pollution, causes, Effects and Control. The Royal Society of Chemistry, Cambridge.
9. Kreth, Frank (ed.) (2002) Handbook of Solid Waste Management, McGraw-Hill, Inc., New Delhi.
10. Singh, J., Kalamdhad, A. S., (2018). Bioavailability, leachability, chemical speciation and bioremediation of heavy metals in the processing of composition. CRC Press, UK.
11. Singh Rudra Pratap, Thenmozhi S., Mayank, Mageshkumar P. (2022). Solid & Hazardous Waste Management. AG Publishing House.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 371
Course Title: Biodiversity: Threats and Conservation
Credits: 04

Maximum marks: 100
University Examination: 60
Sessional Assessment: 40
Duration of Exam: 3 hours

Objectives

The course provides essential knowledge that are fundamental to the study of biodiversity, its measurement, valuation, uses, threats and conservation. It also gives an insight into important organizations and programmes involved for biodiversity conservation and different legal perspectives connected with both biodiversity and conservation.

Unit I: Biodiversity: An introduction

1.1. Biodiversity: Definition, importance and types. Concept of endemic, key stone, flagship and umbrella species.
1.2. Components of biodiversity: Genetic diversity, Species diversity and ecosystem diversity, landscape/pattern diversity, agro-biodiversity, bio-cultural diversity and urban biodiversity.
1.3. Biodiversity patterns through geological times; Biodiversity hotspots (concept and criteria).
1.4. Magnitude of biodiversity: Estimates of biodiversity at global level; extent of known biodiversity in India and Jammu & Kashmir.

Unit II: Measuring biodiversity

2.1. Methods of measuring biodiversity: floral and faunal surveys; physiognomic, phytosociological and grid methods; their advantages and disadvantages.
2.2. Biodiversity surrogates (types and use); role of remote sensing and GIS in biodiversity assessment and monitoring.
2.3. Modern approaches to measuring organismal diversity: species richness, species evenness, measurement of biodiversity at spatial level; Biodiversity indices.
2.4. Biodiversity status: National and Global status, hotspot; threatened species, IUCN Red list, endangered species, vulnerable species, rare species and extinct species.

Unit III: Value and uses of biodiversity

3.1.Biodiversity values: consumptive use value, productive use value, optional value, social value.
3.2.Indirect/non-consumptive use values: ethical and aesthetic values andintellectual value; concept of anthropocentrism, biocentrism, eco-centrism and religious view.
3.3. Methodologies for valuation of biodiversity: Changes in productivity method and Contingent Valuation method.
3.4.Methodologies for valuation of biodiversity: Hedonic Pricing method and Travel Cost method; introduction i.e. ecological economics for estimation of ecosystem services (introduction).

Unit IV: Threats to biodiversity

4.1 Threats to biodiversity: Habitat degradation, deforestation, desertification, Urbanization and pollution.
4.2 Ecological consequences of reduction in biodiversity; Man- Wildlife conflicts.
4.3 Threats to Biodiversity Global estimates of species loss; natural threats to biodiversity.

4.4 Brief account of endangered flora and fauna of India with special reference to J&K.

Unit V: Conservation of biodiversity: National and International Efforts

5.1 In situ conservation: Biosphere reserves, National parks, Wild life sanctuaries, protected area management.
5.2 Ex situ conservation: Botanical gardens, Zoological parks, Herbaria, cryopreservation, seed banks, gene banks, reserve forests, sacred groves and aquaria.
5.3 Global efforts for conserving biodiversity by/through UNESCO, IUCN, WWF, UNEP, WCMC, TRAFFIC, ICIMOD, CITES, Ramsar Convention.
5.4 National efforts: National Biodiversity Authority (2004); National Biodiversity Action Plan (2008); Indian Biodiversity Information Network (IBIN).

Course Outcomes

1. *To understand the importance of biodiversity on earth.*
2. *To gain understanding into the concepts of measuring biodiversity.*
3. *The uses and valuation procedures of biodiversity will be understood by the students.*
4. *The course is intended to impart to students essential knowledge pertaining to loss and threats faced of biodiversity.*
5. *To understand the various conservation strategies being undertaken for conservation of biodiversity at global level and the role of Conservation Organisations as well.*
6. *Understand the legislative implications for the conservation and management of biodiversity in India.*

Note for paper setter:

The question paper will have two sections. Section 'A' will carry 10 compulsory, objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section B will have 10 long answer type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. Ahuja, M. R., Ramawat, K.G. (2014). Biotechnology and Biodiversity. Springer.
2. Armstrong, C. (2024). Global Justice and the Biodiversity Crisis: Conservation in a World of Inequality. United Kingdom: OUP Oxford.
3. Biodiversity Hotspot of the Western Ghats and Sri Lanka. (2024). United States: Apple Academic Press.
4. Gherardi, F., Corti, C. and Gualtieri, M. (2009).Biodiversity conservation and habitat management. Eolss Publishers/UNESCO.
5. Groom, M. J., Meffe, G. R. and C. R. Carroll. (2006). Principles of Conservation Biology. Sinauer Associates, Inc., USA.
6. Khan, T. I. and Shishoda, Y. S. (2005). Biodiversity Conservation and sustainable development. Pointer Publications, Jaipur.Van Dyke, F. 2008. Conservation Biology: Foundations, Concepts and Applications, 2nd Edition Springer.
7. Newton, A. C. (2021). Ecosystem Collapse and Recovery. United Kingdom: Cambridge University Press.

8. Perrings, C. A., Maler, K. G., Folke, C., Holling, C. S. and Jannson, B. O. (2012). Biodiversity conservation: problems and practices.Springer-Science.
9. Pisupati, B., Laladhas, K.P., Oommen, O.V. and Nelliyat, P. (2023) Biodiversity Conservation Through Access and Benefit Sharing (ABS): Himalayas and Indian Sub Continent. Germany, Springer International Publishing.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 372 **Maximum marks: 50**
Course Title: Environmental Impact Assessment **University Examination: 30**
Credits: 02 **Sessional Assessment: 20**
Duration of Exam: 2 hours

Objectives

The goal of the course is to comprehend how a project or other developmental activity affects the environment. Consequently, this study also elaborates on the environmental impact assessment's guiding concepts and procedures as well as its effects.

Unit I Environmental Impact Assessment

1.1. EIA: Concepts, objectives, types, origin and generalized approach to EIA.
1.2. Methodologies of EIA and EIA guidelines (GOI Notification of 1994, 2006).
1.3. Environmental Impact Statement & Environmental Management Plan.
1.4. Environmental Auditing: Concept & guidelines.

Unit II Environmental Impact Assessment: Issues and Concerns

2.1. Impact of tourism on Environment
2.2. Biotic impact on flora & fauna in Himalaya
2.3. An Introduction to Watershed & its management; Wastelands & their reclamation.
2.4. Environmental Education: formal & informal education & their role in environmental Awareness.

Unit III EIA and Sustainable Development

3.1. Environmental priorities in India & sustainable development
3.2. Ecotourism & Environment
3.3. Land use planning: concept, elements to be considered an integrated approach
3.4. Land use capability and suitability classification for sustainable land use.

Course Outcomes:

1. Students will understand the principles, methods, and different approaches of environmental impact assessment.
2. Students will get a comprehensive grasp of the plans for environmental management.
3. The different methods and forms of environmental impact assessments will be thoroughly understood by the students.
4. Pupils will comprehend a range of topics pertaining to sustainable development and EIA.

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Eccleston, C. H. (2011). Environmental Impact Assessment guide to best professional practices. CRC Press.
2. Fonseca Alberto (2022). Handbook of Environmental Impact Assessment. United Kingdom, Edward Elgar Publishing
3. Hanna,K. S. (2009). Environmental Impact Assessment practice and participation. Oxford University Press.
4. Hundloe, T. (2022). Environmental Impact Assessment: Incorporating Sustainability Principles. Switzerland, Springer International Publishing
5. Kevin Hanna (2022). Routledge Handbook of Environmental Impact Assessment. United Kingdom, Taylor & Francis.
6. Manyuchi, Musaida Mercy, et al. (2020). Environmental Impact Assessments and Mitigation. United States, CRC Press.
7. Mareddy, A. R. (2017). Environmental Impact Assessmenttheory and practice**.** BS Publications.
8. Rajora,R. (2002). Integrated Watershed Management. Rawat Publications, Jaipur & New Delhi.
9. Wathern, P. (2013).Environmental Impact Assessment theory and practice. Taylor and Francis.
10. Lekhak Basant, Bhatt Dinesh Prasad (2023). A Textbook of Environmental Impact Assessement. Heritage Publishers and Distributors.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 373 **Maximum Marks: 50**
Course Title: Environmental Microbiology **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Objectives

Main objective of this course is to make the students familiar with microorganisms as these microbes occur in large number in most natural environment and bring about many desirable and undesirable changes. Moreover, they have role in evolution of life on this planet, and their activity is linked directly with processing and removal of dead bodies and sewage. Therefore, study of this course will help the students to develop deep understanding about this ignored group.

Unit I: Introduction and History of Microbiology

1.1 History and scope of microbiology; Branches of microbiology
1.2 Preparation of Media for Isolation and culture of Microorganisms
1.3 Sterilization methods used in Microbiology: heat, chemical and filter method
1.4 Microbial diversity and microbial interactions in environment, biological nitrogen fixation by microorganisms, biofertilizers and biopesticides

Unit II: Industrial microbiology

2.1 Source, Contamination and spoilage of Food
2.2 Preservation and dehydration of food
2.3 Sources and types of microbes in milk, Pasteurization of milk
3.4 Fermentation: Fermented foods, Vegetables and dairy products

Unit III: Advancements in Environmental Microbiology

3.1 White - rot fungal (WRF) technology for treatment of hazardous wastes.
3.2 Bioremediation - concept, types, advantages and disadvantages.
3.3 In-situ bioremediation (Bioventing and Air sparging) and ex-situ bioremediation (Alternate electron acceptors technology and Bioaugmentation)
3.4. Role of genetically modified microorganisms in environmental cleanup

Course Outcomes:

1. *Students will understand the diversity in structure and functioning of microbes.*
2. *Learns about the microbial diversity, biological interaction of microbes with plants and animals.*
3. *Learn about the microbiology of air, water, and soil.*
4. *Learns about the techniques of bioremediation, use of bacteria and fungi in various technologies like bio-augmentation and bio-venting.*

Note for Paper Setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Eldor Paul (2014). Soil Microbiology, Ecology and Biochemistry. Academic Press.
2. Sastry, Apurba Sankar and Bhat, K, Sandhya (2018). Essentials of Practical Microbiology. Jaypee Brothers Medical Publishers; First edition.
3. Alcomo, I.E. (2001). Fundamentals of Microbiology (VI Eds.). Jones and Bartlett Publishers.
4. Agries, G.N. (2005). Plant Pathology (5^{th} Eds.), Acad Press, Inc.
5. Paul, E. (2014). Soil Microbiology, Ecology and Biochemistry (4^{th} Eds.). Academic Press.
6. Frazier,W.C. and D.C.Westheff (2003). Food Microbiology, Tata McGraw Hill Pub. Co. Ltd.
7. Shukla,S.B. And Shantharam (2000). General Microbiology. Oxford & IBH Publishing Co. Ltd. N.Delhi.
8. Tortora, G.J.; Funke, B.R. &Case,C.L.(2012). Microbiology-An Introduction. The Benjamin / Cummings Pub. Co., USA.
9. PommervilleJ.C.(2017). Laboratory Fundamentals Of Microbiology. Jones and Bartlett Publishers, Inc; 11th Revised edition
10. Microbiology, P.D. Sharma (2020). Rastogi Publications, New Delhi.
11. Microbial environment and bioremediation, Chauhan, A., Rathore, A.,(2017). Discovery Publishing House Pvt Ltd.
12. Reineke W., and Schlomann M., (2023). Environmental Microbiology. Springer Berlin Heidelberg.
13. Pepper, I. L., Gerba, C. P., & Gentry, T. J. (2015). *Environmental microbiology*. Academic Press.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 374 **Maximum marks: 50**
Course Title: Intellectual Property Rights **University Examination: 30**
Credits: 02 **Sessional Assessment: 20**
Duration of Exam: 2 hours

Objectives

The aim of this paper is to introduce the basic concept of Intellectual Property Rights to the students and familiarize them with the kinds of rights, remedies and licensing regime associated with each kind of Intellectual Property.

Unit I Introduction to Intellectual Property Rights

1.1 Intellectual Property Rights: Concept, Meaning and historical perspective
1.3 Nature and Characteristics of Intellectual Property Rights.
1.3. Origin and Development of Intellectual Property Rights.
1.4 Kinds of Intellectual Property Rights.

Unit II Theories of Intellectual Property Rights

2.1 Justification and Rationale for Protecting Intellectual Property.
2.2 Balancing the Protection of IPR and Public Policy Objective.
2.3 Theories of IPR: Natural Theory; Hegelian Philosophy (Personality Theory); Lockes' Theory of Property (Labour Theory).
2.2 Social Contract Theory; Social Planning Theory; Incentive Theory; Reward Theory; Prospect Theory; Schumpeterian Theory; Economic Theory.

Unit III International Institutions and Basic International Conventions

3.1 Paris Convention for the Protection of Industrial property, 1883.
3.2 The Berne Convention, 1886; TRIPS Agreement, 1994.
3.3 IPR and sustainable development; The Impact of Internet on IPR.
3.4 IPR Issues in Biotechnology f. E-Commerce and IPR issues International Institutions concerned with Intellectual Property

Course Outcomes:

1. *Students will understand the meaning and historical prospective of IPR.*
2. *An insight to the students about the theories of IPR will be achieved.*
3. *An understanding of the international institutions and conventions related to IPR will be understood.*
4. *Knowledge related to IPR and sustainable development will be gained.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum- short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6

questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Bainbridge, D. I. (2012). Intellectual Property, Longman, 9th Edition.
2. Bosworth, D. and Webster, E. (2006). The management of Intellectual Property. Edward Elder Publishing Ltd.
3. Pandey, N. and Dharni, (2014). Intellectual Property Rights. PHI Learning Pvt. Limited.
4. Ramakrishna, B. and Anil Kumar, H. S. (2017). Fundamentals of Intellectual PropertyRights for students, industrialists and patent lawyers. Notion Press.
5. Sell, S. G. (2003). Private Power, Public Law: The Globalization of Intellectual Property Rights, Cambridge University Press.
6. Singh, R., Sinha, S. K. and Kumar, S. (2019). Unfolding Intellectual Property Rights. Notion Press.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 375 **Maximum Marks: 50**
Course Title: Forest Management -I **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

This course is designed to provide students with the conceptual background needed to understand the complexity of interactions that occur within a forest ecosystem over time.

Unit I: Forest and forest environment

1.1. Forest and forest environment: what are forests; importance of forests in environmental conservation, wildlife, and biodiversity.
1.2. Forest ecosystem concept: introduction, composition & structure of forest ecosystem.
1.3. Forest stand, pure & mixed stand, even & uneven aged stand, use of mixed stand, irregular stands.
1.4. Relationship between man and forest in the Himalaya; major and minor forest produce; forests for food.

Unit II: Forest ecosystem functions

2.1. Forest ecosystem function: Primary productivity of forest ecosystems; methods of measurement; productivity patterns.
2.2. Forest litter: types of litter and coarse woody debris, litter fall, forest floor litter mass; importance of forest litter.
2.3. Litter decomposition and factors affecting it, such as microbes, fauna, abiotic factors and litter characters.
2.4. Nutrient cycling and nutrient conservation strategies. Water cycle in a forested area: impact of forest on precipitation, role of water in nutrient cycling.

Unit III: Changes in forest ecosystems

3.1. Eco-physiology of forest trees: characteristics of tropical trees; shoot growth in forest trees.
3.2. Phenology of trees; forest seed dormancy and germination; regeneration ecology of forest trees.
3.3. An idea of forest succession with particular reference to Himalaya.
3.4. Attributes of species of different successional stages, recovery measures of disturbed sites, species selection for disturbed sites in Himalaya.

Course Outcomes:

1. *The basic concepts regarding the different ecological process will be understood by the students.*
2. *Knowledge related to interaction between different components that occurs within a forest ecosystem over a period of time will be gained by the students.*
3. *The need of forest ecosystem and ecosystem services in present scenario will be realized by the students.*

4. *The structure, functions and health of the forest ecosystem will be understood by the students.*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory, having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Newton, A. (2007). *Forest Ecology and Conservation.* Oxford University Press.
2. R. H. Waring and W. H. Schlesinger. (2007). Forest Ecosystems: Concepts and Management (3rd Eds). Academic Press, Orlando.
3. Raymond, Y. A. and Ronald G. L. (2003). *Introduction to Forest Ecosystem*: S*cience and Management* (3rd edition). John Wiley and Sons.
4. Champion, H. G. and Seth, S. K. (2004). *A Revised Survey of the Forest Types of India* Natraj Publicaiton, Dehradun.
5. Evans, J. and Turnbull, J. (2004). *Plantation Forestry in the Tropics* (3rd Edition). Oxford University Press.
6. Kimmins, J. P. (2004). *Forest Ecology* (2nd edition). Pearson Education.
7. Barnes, B. V, Zak, D. R, Denton, S. R. and Spurr, S. R. (1998). *Forest Ecology* (4th edition). John Wiley and Sons.
8. Singh, S. P. and Singh, J. S. 1992. Forests of the Himalaya: Structure, Functioning and Impact of Man. Gyanodaya Prakashan, Nainital, India, pp 294.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 376 **Maximum Marks: 50**
Course Title: Behavioural and Wildlife Ecology-I **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

The paper aims to understand wildlife habitat management in protected areas, its requirement, and importance and also educate and make aware of illegal trade in wildlife and various wildlife products. Paper further discuss the Major National and International agencies such as BNHS, WPSI, WWF, and IUCN.

Unit I: Protected Area Management

1.1 An overview of PA network in India with special reference to J&K: types of protected areas and the concept of zoning within the protected areas.
1.2 Livestock grazing and its impact on wildlife habitats. Management issues in Protected areas; Accidental and intentional fires and its impact on soil, fauna, and flora.
1.3 A critical analysis of reducing human dependence on protected areas through case studies.
1.4 Current practice in PA management e.g. Eco-development, village relocation

Unit II: Wildlife Trade

2.1 Introduction to wildlife trade. Legal and illegal trade of faunal and floral species.
2.2 National and International perspective of wildlife trade. An overview of major species of different faunal and floral groups involved in wildlife trade.
2.3 Role of the State forest department and Wildlife Crime Control Bureau for curbing the menace of illegal wildlife trade. Role of judiciary and NGOs.
2.4 Role of an International organization such as CITES, TRAFFIC, WWF-International and other organization in dealing with wildlife trade

Unit III: Threats, Legislation and Mitigation Strategies

3.1 An overview of major threats to wildlife values in India.
3.2 Concept of IUCN threat categories. Red Databook. Salient features of the Wildlife Protection Act 1972.
3.3 Organisational structure for the conservation of wildlife values of India.
3.4 Major mitigation strategies and the role of NGO's such WWF, WPSI, WPTI, BNHS etc.

Course Outcomes:

1. *Develop an understanding of Protected Area Management in India*
2. *Legal and illegal trade of faunal and floral species*
3. *Impact of wildlife trade on populations and ecosystem*

4. *Understand major threats to wildlife and mitigation*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory, having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. G.S. Shukla and Upadhay (2001): Economic Zoology, Rastogi publications, Meerut, 4th Edition.
2. Gopal Rajesh (2012): Fundamentals of wild life management, S. Chand Publishers, 7th Edition.
3. Negi S. S. (2012): Wild life conservation, Natraj Publishers 5th Edition.
4. P. Malhotra (2008): Economic Zoology, Adhyayan Publishers, New Delhi, 5th Edition.
5. Pradip. V. Jabde (2005): Text book of applied zoology, Discovery publishing house, New Delhi. 1st Edition.
6. Richard. E. Blackwelder (1996): Taxonomy A text and reference book, Jhon Wiley and Sons INC, NewYork, London, Sydney, 3rd Edition.
7. Handbook of National Parks, Wildlife Sanctuaries and Biosphere Reserves in India by S.S.Negi, Indus Publishing
8. Wildlife Biology: An Indian Perspective by Goutam Kumar Saha
9. Conservation Biology: A Primer for South Asia by Kamaljit S Bawa
10. The Illegal Wildlife Trade: Inside the World of Poachers, Smugglers and Traders (Studies of Organized Crime) by Daan P. van Uhm
11. Protected Landscapes: A Guide for Policy Makers and Planners (The Iucn Conservation Library) by P.H.C. Lucas
12. Environmental law in India by P. Leelakrishnan
13. The Wildlife (Protection) Act 1972 (up to latest amendment)

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 377 **Maximum Marks: 50**
Course Title: Limnology-I **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

The present course is design to supply information on various aspects of introduction and importance of inland water resources and the organisms inhabiting them.

Unit I: Limnology: An introduction

1.1 History and scope of Limnology in India.
1.2 Water bodies (Lentic and lotic): Origin & Classification.
1.3 Lakes: Origin & Classification; Eutrophication and its restoration.
1.4 Rivers: Origin & Classification; Abiotic & Biotic characteristics.

Unit II: Estuaries and marshes: An introduction and their Importance

2.1 Estuaries: Origin and classification.
2.2 Bogs: Origin & types; Abiotic and biotic characteristics
2.3 Marshes: Origin and characteristics
2.4 Vernal pools and their significance

Unit III: Aquatic organisms

3.1 Plankton: Definition, Classification, importance and management.
3.2 Phytoplankton: Composition & Distribution in aquatic ecosystem; Role of Organic nutrients in Phytoplanktonic growth; Floating adaptation.
3.3 Zooplankton: Composition & distribution; Cyclomorphosis; Role in aquaculture.
3.4 Benthos: Composition, Distribution and their role in Aquatic ecosystems

Course Outcomes:

1. *The students will understand the concepts related to the inland aquatic environment.*
2. *Students will develop the understanding about ecological classification of the fresh water organism.*
3. *Students would develop an understanding with respect to limnological aspects of inland freshwater resources.*
4. *The relation of inland water resources with the terrestrial ecosystem will be appreciated.*
5. *Students will also understands the biological diversity of lentic and lotic water bodies.*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Chhapgar, B.F. (2008). Fishes of India (WWF Natures Guide). Oxford University Press
2. Patra, K.C. (2008). Hydrology and water resources engineering. Alpha Science International Ltd; 2nd Revised edition.
3. India's Wetlands Mangroves and Coral Reefs (1992). WWF India.
4. Abbasi, S. A. (1997). Wetlands of India. Discovery Publishing House. New Delhi.
5. Schowoerbel, J. (1991). Handbook of limnology. Scientific publ. Jodhpur.
6. Aggarwal, S. C. (1999). Limnology. APH Publ. Corp., New Delhi
7. Goldman, C. R. and Horne, A. J. (1994). Limnology. Mc. Graw Hill Int. Book Co., New Delhi
8. Jocelyne Hughes (2019) Freshwater Ecology and Conservation: Oxford University Press

M. Sc. Environmental Sciences, Semester III

Course Code: EVS 390 **Maximum marks: 100**
Course Title: Based on EVS 370, EVS 372 and EVS 373 **University Examination: 50**
Credits: 04 **Sessional Assessment: 50**
Duration of Exam: 3 hours

1. Field visit to assess various types of environmental hazards to workers working in different industrial units.
2. Different methods for the collection of municipal solid waste and its disposal in your community.
3. Study and characterize of waste of BGSBU Campus.
4. Prepare a questionnaire to study the impacts of various types of hazards to the society.
5. A field visit for the preliminary assessment of environmental impact of different developmental project.
6. Prepare a questionnaire to study the social impacts of developmental projects.
7. A field visit to assess various types of environmental hazards to workers working in different industrial units.
8. Understand the computer modelling method for EIA.
9. Field visit to assess various types of environmental hazards to workers working in different industrial units.
10. Different methods for the collection of municipal solid waste and its disposal in your community
11. Study and characterize of waste of BGSBU Campus.
12. Study the principle, construction and working of Autoclave and Incubator.
13. Study the principle, construction and working of Laminar Air Flow and Centrifuge.
14. Study the type of bacteria in curd by Gram staining technique.
15. Calculate the number of bacteria in given sample of milk by DMC method.
16. Prepare potato dextrose agar/ nutrient agar medium, sterilize and prepare plates of the medium for culture and study of microbes
17. Isolation of microorganism from given soil/ water sample by serial dilution
18. Isolation of pure culture using streak plate technique
19. Study the growth /colonies of different microbes present in the Petri plate.
20. Find out the drinking water quality by MPN method.

M. Sc. Environmental Sciences, Semester III

Course Code: EVS- 391 **Maximum marks: 100**
Course Title: Based on EVS 371, EVS 375 **University Examination: 50**
EVS 376/EVS 377 **Sessional Assessment: 50**
Credits: 04 **Duration of Exam: 3 hours**

1. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
2. To determine the minimum size of the quadrat by species area curve method.
3. To study the community characteristics by quadrat method by determining frequency, density and abundance of different species in the community.
4. To compare the biomass and net primary production of managed and unmanaged sites.
5. To study the biotic components of a pond ecosystem.
6. Study of community structure and assessing frequency of the species as assessed by Raunkiaer (1934). Prepare a frequency diagram and divide the species into classes based on percentage frequency (Raunkiaer, 1934).
7. Exploratory trip for plant collection/ visit to National Parks/Wildlife Sanctuaries/Botanical gardens/Herbaria.
8. To study the principle, construction and working of Autoclave and Incubator.
9. To study the principle, construction and working of Laminar Air Flow.
10. To study the type of bacteria in curd by Gram staining technique.
11. To calculate the number of bacteria in given sample of milk by DMC method.
12. To calculate the number of bacteria per ml. in a given sewage sample by DMC method.
13. Prepare potato dextrose agar medium, sterilize and prepare plates of the medium for culture and study of microbes.
14. To study the growth /colonies of different microbes present in the Petri plate.
15. To find out the drinking water quality by MPN method.
16. Prepare MacConkey's agar medium, sterilize and prepare plates of medium.
17. To study the different colonies present in the Petri plate of medium for differentiation of Lactose fermentor and non-lactose fermentor bacteria.
18. To study the phenology and leafing pattern of different tree species.
19. Study the regeneration status of the important tree species of Pir Panjal Biodiversity Park.
20. To determine periodic girth increment of different forest trees of Pir Panjal Biodiversity Park.
21. Study of community structure and assess the density and abundance of the species.
22. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species.
23. Identification of mammalian fauna of Rajouri region.
24. Identification of avian fauna of Rajouri region.
25. Identification of herpeto-fauna of Rajouri region.
26. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses, Camera trap, Sherman trap, Camping gear).
27. Identification/preparation of museum specimens. Precautions taken in the field.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 470 **Maximum marks: 100**
Course Title: Environmental Policies and Regulations **University Examination: 60**
Credits: 04 **Sessional Assessment: 40**
Duration of Exam: 3 hours

Objectives

This course's primary goal is to familiarize students with the fundamentals of environmental laws, policies, and regulations so they can use their professional skills appropriately and effectively.

Unit I: Introduction to Environmental Laws

1.1 Environmental Protection: Issues & Problems.
1.2 Key International Efforts for Environmental Protection.
1.3 Sustainable Development: Essential features and Legal Implications.
1.4 UN Framework Convention on Climate Change, 1992 & Kyoto Protocol, 1997.

Unit II: Environmental Protection and the Laws

2.1 Salient Features of Environment (Protection) Act, 1986.
2.2 Powers of Central Government under EPA: Prevention, Control & abatement of environmental pollution under EPA.
2.3 Hazardous wastes (Management, Handling and Transportation) Rules, 2008.
2.4 Public Liability Insurance Act, 1991

Unit III: Pollution Abatement and the Laws

3.1 Water (Prevention & Control of Pollution) Act, 1974: Salient Features.
3.2 Powers and Functions of CPCB & SPCB under Water Act.
3.3 Air (Prevention & Control of Pollution) Act, 1981.
3.4 Powers and Functions of CPCB & SPCB under Air Act.

Unit IV: Natural Resource Conservation and the Laws

4.1 Wildlife (Protection) Act,1972: Salient Features.
4.2 Protected Areas and Trade & Commerce under WPA.
4.3 National Forest Policy & Forest Conservation Act, 1986.
4.4 Biological Diversity Act, 2002 and Rules (2004).

Unit V: Judicial Activism and Environmental Protection

5.1 Indian Constitution and Environmental Protection
5.2 Judicial Response towards Environmental Protection
5.3 Public Nuisance under IPC (Sections 268, 277, 278, 284, 290, 291); Sections 133-143 of

Criminal Procedure Code, 1973.

5.4 Role of NGO's for the promotion and protection of Environment.

(Note: Only the relevant provision of the above Acts are to be emphasized)

Course Outcomes:

1. Students will comprehend the concerns and difficulties pertaining to the environment.

2. Students will gain knowledge about significant global environmental protection initiatives.

3. Students will learn about environmental laws and their key components.

4. Students will be aware of judicial activism for environmental protection.

Note for the paper setter:

The question paper will have two sections. Section A carrying 10 compulsory, objective-cum-short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 10 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry1 0marks.

Note for the paper setter:

The question paper will have two sections. Section A carrying 10 compulsory, objective-cum-short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 10 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 10 marks.

Books recommended:

1. Diwan,P. (2002). Environmental Administration - Law & Judicial Attitude, Vol. I, II. Deep & Deep Pub. New Delhi.
2. Divan, S.and Roscencranj, A. (2012). Environmental Law & Policy in India. Oxford Pub. New Delhi.
3. Dwivedi, O. P. (2016). Indian's environmental policies, programmes and stewardship. McMillan Press Ltd.
4. Ghosh, S. (2019). Indian Environmental Law: key concepts and principles. Orient lack Swan.

5. Leelakrishnan, P. (2016). Environmental Law in India. Butterworths Publications, N.Delhi.
6. Sahasranaman, P. B. (2012).Handbook of Environmental Law. OUP, India
7. Divan, S., and Armin R., (2022). *Environmental Law and Policy in India: Cases and Materials, 3rd Edition.*
8. Pithawalla H.D., (2024). Environmental laws. C Jamnads and Co.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 471 **Maximum marks: 50**
Course Title: Remote Sensing and Geographical Information System **University Examination: 30**
Sessional Assessment: 20
Credits: 02 **Duration of Exam: 2 hours**

Objectives

Remote Sensing Technology is an important tool to map & monitor changes of the natural resources & environment. The study is helpful to improve our ability to achieve the goal of optimum land use planning & in turn sustainable resource management & development. This course is focused to acquaint the students with basic remote sensing principles, concepts & their applications in various fields.

Unit I Introduction to remote sensing

1.1 Remote sensing: Definition, Concept of Electromagnetic radiation (EMR); Electromagnetic Spectrum; Radiation principles, Scope of remote sensing.
1.2 EMR interaction with Atmosphere & Terrain.
1.3. Platforms and Sensors: Classification of Platforms, Basic Characteristics of Sensors and Spatial, Spectral, Temporal, Radiometric resolutions
1.4 Remote sensing systems: Framing and Scanning Systems.

Unit II Microwave and thermal remote sensing & GIS

2.1 Microwave remote sensing: introduction, advantages, active remote sensing components.
2.2 Radar operating principles, radar return, spatial resolution in radar, slar, sar, space borne radarimage characteristics & interpretation of radar images.
2.3 Thermal remote sensing: concept, thermal infrared radiation properties, application of thermal infrared remote sensing.
2.4Geographical information system (GIS): definition, components of GIS, geographical data & database structures; spatial data models viz. raster and vector, data input & output in GIS.

Unit III Remote sensing & GIS applications

3.1 Remote sensing & GIS application in Forestry, Ecology & Environment.
3.2 Remote sensing & GIS application in Agriculture, Soil survey and soil mapping.
3.3 Remote sensing & GIS application in Land use/ land Cover & land evaluation.
3.4 Remote sensing & GIS application in Disaster Management.

Course Outcomes:

1. *Students will understand the various concepts, principles and scope of Remote Sensing and GIS.*

2. *Various Remote sensing system and their salient features will become known to the taught.*
3. *Understanding about various remote sensing techniques will be developed by the students.*
4. *The application regarding the assessment and mapping of environment using GIS will be developed by the students.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 6 compulsory, objective-cum-short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 6 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Burrough, P.A. (2008). Principles of Geographical Information System for Land Resource Assessment.Oxford Univ. Press.
2. Chuvieco, E. (2020). Fundamentals of Satellite Remote Sensing. Taylor and Francis.
3. Emery, W. and Camps, A. (2017). Introduction to Satellite Remote Sensing. Elsevier.
4. Jensen,J.R.(2003).Remote Sensing of the Environment, Pearson Education, Singapore.
5. Jon, R. J. (2015). Introduction digital Image Processing: A remote sensing perspective. Prentice & Hall.
6. Lilles ,T.M., Kiefer R.W & Johnathan, C. (2015).Remote Sensing & Image Interpretation. Second Ed. John Wiley & Sons, NewYork. Bhatia, S. C., (2023). *Fundamentals of Remote Sensing*. Atlantic Publishers and Distributors (P) Ltd.
7. Sahu, K. C., (2022). *Textbook of Remote Sensing and Geographical Information Systems*. Atlantic Publishers and Distributors (P) Ltd.
8. Bhatta, B., (2021). *Remote Sensing and GIS* (3rd Edition). OUP India.
9. Mueller, T., &Sassenrath, G. F., (2021). *GIS Applications in Agriculture, (Volume 4*). Taylor & Francis Ltd.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 472 **Maximum Marks: 50**
Course Title: Biostatistics **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Objectives

Biological statistics helps the biologists to understand the nature of variability and to assess and represent it quantitatively. Keeping in view, the course has been specifically designed to help the students to perform statistical calculations so as to present the result in more meaningful manner.

Unit I: Introduction to Biostatistics

1.1 Statistics: definition, history, applications and limitations; concept of biometry.
1.2 Sampling of data - random and non-random sampling.
1.3 Representation of data: Diagrammatic (Line, bar, pie diagram).
1.4 Representation of data: Graphic (Histogram, frequency polygon, frequency curve, cumulative frequency curve);Limitations of graph.

Unit II: Basics of biostatistics

2.1Classification of data; Data collection and tabulation, primary and secondary data, methods of collecting primary data; sources of secondary data.
2.2 Editing of primary and secondary data, rule of tabulation, parts and types of tables and role of tabulation of data.
2.3 Merits and demerits of measures of central tendency: arithmetic mean, median, mode.
2.4. Measures of dispersion: standard deviation, standard error and coefficient of variation.

Unit III: Application of biostatistics

3.1 Hypothesis testing; Tests of significance: T-test, F-test and Chi square (X^2) test.
3.2 Probability distribution: Binomial, Poisson and Normal distribution; Deviation, properties and applications of normal distribution.
3.3 Correlation: types, methods; Karl Pearson's coefficient and regression (linear) analysis and their uses.
3.4 Principles of experimental designs: Completely Randomised Designs (CRD) and Randomised Block Designs (RBD); ANOVA

Course Outcomes:

1. *Knowledge gained about Biological statistics by the students will be used in multiple applications.*

2. *Students will be able to understand about the various applications of Mathematics and Statistics in Environmental Sciences.*
3. *Accordingly students will be able to apply the knowledge gained in their respective research programmes.*
4. *They will be able to analyze information based on mathematical data rather than accumulating and memorizing it.*

Note for the paper setter:

The question paper will have two sections. Section "A" will carry 6 compulsory Objective-cum-short answer type questions, two from each unit. Each question will carry 01 mark. Section "B" will carry 6 long answer-type questions, two from each unit. The students will be required to attempt 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Chaudhry, K., Chaudhry, S., Bollu, P. (2024). Basic Epidemiology and Biostatistics: A Practical Guide. United Kingdom: Elsevier Science.
2. Faizi, N., Alvi, Y. (2023). Biostatistics Manual for Health Research: A Practical Guide to Data Analysis. United Kingdom: Elsevier Science.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2018). Fundamentals of Statistics. The World Press Pvt. Ltd, Kolkata.
4. Gupta, C.B. and Gupta, V. (2005). An Introduction to Statistical Methods. Vikas Publishing House Pvt Ltd, New Delhi.
5. Gupta, S.C. (1999). Fundamentals of Statistics. Himalayan Pub. House Delhi.
6. Gupta, S.P. (2011). Statistical Methods. Sultan Chand and Sons, New Delhi.
7. MacFarland, T. W. (2024). Introduction to Data Science in Biostatistics: Using R, the Tidyverse Ecosystem, and APIs. (n.p.): Springer International Publishing.
8. Roy, U. K., Choudhury, S. (2023). Biostatistics in Health Research. (n.p.): Amazon Digital Services LLC - Kdp.
9. Sharma, S. (2022). Nursing Research and Statistics - E-Book. India: Elsevier Health Sciences.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 473 **Maximum marks: 50**
Course Title: Environmental Biotechnology **University Examination:30**
Credits: 02 **Sessional Assessment: 20**
Duration of Exam: 2 hours

Objectives

The course presents an insight into the diverse applications of environmental biotechnology. The course proposes to cover the modern biotechnological tools for environmental applications and sustainable development.

UNIT I: Environmental Biotechnology: An Introduction

1.1 Environmental Biotechnology: Concept & Historical perspective.
1.2 Bioprocesses for Cleaner Production. Biotechnological Research and Development.
1.3 Bioethics, Genetic Engineering: Introduction to Recombinant DNA Technology,
1.4 Public Perception of Biotechnology, Future of Biotechnology.

UNIT II Novel Methods for Pollution Control

2.1 Biosorption - use of bacteria, fungi and algae in biosorption.
2.2 Bioabatement of metal pollution using higher and lower plants.
2.3 Microbial treatment of oil pollution. Nanotechnology for control of pollution
2.4 Role of genetically engineered microbes in pollution control, Biofilms and microbial mats.

UNIT III: Recycling and Reclamation

3.1 Use of mycorrhizae in reforestation; Use of microbes as bioinsecticide, biofungicide and bioherbicides.
3.2 Biotechnology strategies in forestry and wasteland management.
3.3Biodegradable plastics – Bioplastics Genosensor technology; Biosensors and their application in environmental monitoring.
3.4 Reclamation of wasteland, microorganisms in mineral and energy recovery

Course Outcomes:

1. *To provide theoretical and practical knowledge on different aspects of biotechnology to the students.*
2. *To develop understanding about the basics of biotechnology.*
3. *To understand the significance of environmental biotechnology in control of pollution.*
4. *At the end of the course, students should be able to associate the biotechnology tools in environmental applications and articulate the available modern tools of biotechnology for environmental remediation.*

Note for the paper setter:

The question paper will have two sections. Section A carrying 06 compulsory, objective-cum-short answer type questions, two from each unit. Each part will carry 01 mark. Section B will have 06 questions, two from each unit. The students will attempt 1 question from each unit. Each question will carry 08 marks.

Books recommended:

1. Abbasi, S.A. & Ramasami,E. (1999). Biotechnological Methods of Pollution Control. Unviersities Press (India) Ltd., Hyderabad.
2. Chaterjii, A. K. (2002). Introduction to Environmental Biotechnology. Prentice Hall of India. Pvt. Ltd. N. Delhi.
3. Fulekar M. H. (2010). Environmental Microbiology. New York, Taylor & Francis.
4. Gupta, P.K. (1994). Elements of Biotechnology. Rastogi & Co. Meerut
5. Jogdand, S.N.(1995). Environmental Biotechnology. Himalayan Publishing House, New Delhi
6. Koukkou A. I. (2011). Microbial Bioremediation of Non-metals: Current Research. Haverhill, U K, Caister Academic Press.
7. Lederberg J. (1992). Encyclopedia of Microbiology, New York: Academic Press.
8. Maier R. M., Pepper I. L., Gerba C. P. (2006). Environmental Microbiology. San Diego, Elsevier Academic Press.
9. Passman F. J. (2003). Fuel and Fuel System Microbiology: Fundamentals, Diagnosis and Contamination Control. West Conshohocken, ASTM International.
10. Purohit, S. S. & Mathur, S. K. (1996). Biotechnology Fundamentals &Applications. Agro botanical Publication, New Delhi.
11. Sangeetha J, Thangadurai D, David M, Abdullah M. A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation and Bioconversion of Xenobiotics for Sustainable Development, Boca Raton, Florida, USA, CRC Press.
12. Reineke, W., & Schlömann, M., (2023). *Environmental Microbiology*(1st Edition). Springer Spektrum.
13. Rittmann, B. E., & Mc Carty, P. L., (2021). *Environmental Biotechnology* (2nd Edition). McGraw Hill.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 474 **Maximum Marks: 200**
Course Title: Dissertation **Sessional Assessment: 50**
University Examination: 150

Credits: 08

Students will undertake field study/experimental study, which will be submitted as dissertation and will be evaluated by external/ internal examiners. The viva voce/presentations will be conducted by the external/ internal examiners.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 475 **Maximum Marks: 50**
Course Title: Forest Management-II **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

This course is designed to acquaint students with the types of forests; its structure, functioning and policies and laws related to management and conservation. It also provides information on forest ecosystem services

Unit I: Structure and functioning of forests

1.1. Major forest types of the world; forest cover and forest types of India, with special reference to J&K
1.2. Structure of major forest types in India: tropical rain forests, monsoon forests, temperate coniferous and temperate deciduous forests, boreal forests and timber line areas.
1.3. Abiotic factors affecting forest ecosystem: climatic factors (solar radiation, wind, temperature, precipitation; edaphic factors (soil profile, physical and chemical properties of forest soil).
1.4. Biotic factors affecting forest ecosystem: competition, epiphytes, climbers, weeds, wild animals and man; diseases of important forest tree species (teak, pine and deodar); rots in hardwood and softwood and their preventions.

Unit II: Forest ecosystem: services and management

2.1. Ecosystem services: definitions, concepts, background especially in relation to the Himalayan Forests.
2.2. Markets for ecosystem services: carbon science; carbon market; water, wildlife, biodiversity, wildlife habitat and other services.
2.3. Ecosystem services: global and national scenario; advantages, and peoples participation in conservation and management.
2.4. Principles of forest management; scope and objectives of forest management; ecosystem management, development of forest management in India.

Unit –III: Forest Policy and Laws

3.1. Forest policy- concept, objectives and scope; Jammu and Kashmir State Forest Policy (brief account).
3.2. National Forest Policy- 1894, 1952 and 1988: concept, objectives and scope (general account).
3.3. Forest Laws: Indian Forest Act- 1927; Wildlife Protection Act 1972 concept, objectives and scope (general account).
3.4. Forest Conservation Act; Forest Rights Act; Social Forestry; Urban Forestry: concept, objectives and scope.

Course Outcomes:

1. *The Diversity of forest types in India in general and Jammu and Kashmir in particular will be known to the students.*
2. *The students will be able to learn the forest policies of the India and J&K.*
3. *Information on various factors responsible for destruction of forest ecosystem will be understood by the students.*
4. *The different issues, policies and laws related to the forest management and conservation will be known to the students.*
5. *Impact of climate change on forest ecosystem will be understood by the students.*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

9. Newton, A. (2007). *Forest Ecology and Conservation.* Oxford University Press.
10. R. H. Waring and W. H. Schlesinger. (2007). Forest Ecosystems: Concepts and Management (3rd Eds). Academic Press, Orlando.
11. Raymond, Y. A. and Ronald G. L. (2003). *Introduction to Forest Ecosystem*: S*cience and Management* (3rd edition). John Wiley and Sons.
12. Champion, H. G. and Seth, S. K. (2004). *A Revised Survey of the Forest Types of India* Natraj Publicaiton, Dehradun.
13. Evans, J. and Turnbull, J. (2004). *Plantation Forestry in the Tropics* (3rd Edition). Oxford University Press.
14. Kimmins, J. P. (2004). *Forest Ecology* (2nd edition). Pearson Education.
15. Barnes, B. V, Zak, D. R, Denton, S. R. and Spurr, S. R. (1998). *Forest Ecology* (4th edition). John Wiley and Sons.
16. Diwedi, A. P. (1993). *Forestry in India,* Surya Publications, Dehradun.
17. Perry, D. A. (1994). Forest Ecosystems. The Johns Hopkins University Press. Baltimore

18. Puri, G. S., V. M. Mehar-Homji, R. K. Gupta and R. K. Puri (1960). Forest Ecology. Oxford and IBH Pub. Co., New Delhi.
19. Richards, P. W. (1996). The *Tropical Rain Forest* (2nd edition). Cambridge University Press.
20. Singh, S. P. and Singh, J. S. 1992. Forests of the Himalaya: Structure, Functioning and Impact of Man. Gyanodaya Prakashan, Nainital, India, pp 294.
21. Whitmore, T. C. (1998). *The Tropical Rain Forest*. Oxford University Press.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 476 **Maximum Marks: 50**
Course Title: Behavioural and Wildlife Ecology–II **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

This paper aims to provide students with insight into issues related to wildlife conservation. Classroom teaching would focus on different bio-geographic zones and discusses the economic importance, threats and threatened birds of the India with special reference to J&K.

Unit I: Wildlife Conservation

1.1 Wildlife: definition and concept, Conservation issues of Wildlife.
1.2 Economic Importance of wildlife: beneficial and harmful role.
1.3 Threats faced by Wildlife: overexploitation: hunting and poaching
1.4 Man and Wildlife conflicts. Wildlife tourism: objectives, planning and economics

Unit II: Bio-geographic Classification of India

2.1 Basis of bio-geographic classification.
2.2 Concept of bio-geographic zones, provinces and biomes.
2.3 Distribution of major wildlife values (plants, mammals, birds, herpetofauna, etc.) in different bio-geographic zones.
2.4 Biogeographic realms and affinities of flora and fauna of Indian sub-continent.

Unit III: Ornithology

3.1 Classification and distribution of Indian avifauna up to species level.
3.2 Bird species identification through morphological studies.
3.3 Economic importance of birds, beneficial and harmful role of birds, problem birds and their control.
3.4 Threats faced by the avian community, threatened birds of the India with special reference to J&K, causes of decline of common birds and control measures.

Course Outcomes:

1. *Wildlife conservation issues & their economic Importance*
2. *Bio-geographic classification & distribution of wildlife in these bio-geographic zones*
3. *Distribution and classification of birds*
4. *Threats faced by avian community and their control measures*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

1. Dasmann, R.F. 1981.Wildlife Biology. 2nd Ed. Johm Wiley and Sons.
2. Caughley, G., and Sinclair, A.R.E. 1994. Wildlife Ecology and Management.Blackwell Science.
3. Sutherland, W.J. 2000. The Conservation Handbook: Research, Management and Policy. Blackwell Sciences.
4. Bookhout, T.A. 1996. Research and Management Techniques for Wildlife and Habitats, 5th Ed. The Wildlife Society, Allen Press.
5. Woodroffe R., S. Thirgood and A. Rabinowitz. 2005. People and Wildlife, Conflict or Coexistence? Cambridge University.
6. Caughley, G. 1977.Analysis of vertebrate populations.John Wiley and Sons.
7. Rangarajan M. 2001. India's Wildlife History. Permanent Black.
8. Wildlife Conservation and Management by ReenaMathur, Rastogi Publications, Pp 472
9. Birds of the Indian subcontinent by Grimmett, R., Inskipp, C. &Inskipp, Tim, Pp 888
10. Indian Mammals: A Field Guide by VivekMenon, Hachette India, Pp 528
11. The life of birds by Joel Carl Welty
12. Ornithology by Frank, B. Gill
13. The book of Indian birds by Salim Ali
14. The fall of Sparrow by Salim Ali
15. Avian Ecology by Birkhead and Perrins
16. Popular handbook of Indian bird by Hugh Whistler

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 477 **Maximum Marks: 50**
Course Title: Limnology-II **Sessional Assessment: 20**
University Examination: 30
Credits: 02 **Duration of Exam: 2 hours**

Choice-based Complimentary Elective

Objectives

The present course is design to supply information on various aspects of aquatic environment, physico-chemical properties, characteristics conservation and management prospectives.

Unit I Features and Flora of aquatic ecosystem

1.1 Physical features and their importance: Light, Turbidity and Currents.
1.2 Chemical features of Freshwater system and their importance: pH, D.O.
1.3 Macrophytes: importance, classification and management.
1.4 Aquatic organisms- Fishes and birds: importance, causes of their depletion & conservation

Unit II Aquatic Environment: related phenomenon

2.1 Wetland: Introduction, Characteristics & Management techniques
2.2 Concept and mechanism of Acidification.
2.3 Concept and mechanism of Translocations.
2.4 Thermal stratification: Concept and importance.

Unit III Aquatic Environment: Conservation and management

3.1 Ramsar's role in water resource management; Integrated framework for wetland inventory, assessment and monitoring.
3.2 Ramsar framework for wetland inventory and management
3.3 National Water Policy; causes for dwindling of fresh water resources; Water conservation.
3.4 Development of National Wetland Policy (as per Ramsar convention).

Course Outcomes:

6. *The students will understand the concepts related to flora and features (physical and chemical) of the aquatic environment.*
7. *Students will develop the understanding about ecological classification of the fresh water organisms.*
8. *The course will enable to develop understanding about the conservation and management of the aquatic environment among students.*
9. *The students will understand the various policies related to water conservation, management and rehabilitation aspects of wetlands.*

Note for the paper setter:

The question paper will have 2 Sections. Section 'A' will be compulsory having 6 questions of 01 mark each. The questions will be either short answer type having answers not exceeding 20 words or multiple choice type having four options each or fill in the blanks type. Section 'B' will carry 6 long answer type questions, two from each Unit. The students will be required to answer 1 question from each unit. Each question will carry 8 marks.

Books recommended:

9. Bal, A.S (2005). An Introduction to Environment Management. Himalaya Publishing House, Mumbai.
10. Chhapgar, B.F. (2008). Fishes of India (WWF Natures Guide). Oxford University Press
11. Hutchinson, G. E. (2004). Treatise on Limnology. Vol. I, part-2, Vol. II. John Willey and Sons, New York.
12. Reynolds, C.S., O'sullivan, P.E. and Meadow, S.R. (2004).The Lakes Handbook (Volume 1): Limnology and Limnetic Ecology. Oxford University Press.
13. Sinha, P. C. and Mohanty, R. (2002). Wetland Management Policy and Law. Kanishka Publishers, Distributors, New Delhi.
14. Wetzel, R. G. (2002). Limnology Lakes and River Ecosystem. Academic Press, London.

M. Sc. Environmental Sciences, Semester IV

Course Code: EVS 490 **Maximum Marks: 100**
Course Title: Based on EVS 471, EVS 472 & EVS 473 **University Examination: 50**
EVS 475/EVS 476/EVS 477 **Sessional Assessment: 50**
Credits: 04 **Duration of Exam: 3 hours**

1. Study of satellite images and aerial photographs, information recorded on the Remote Sensing data sets.
2. Study of toposheets and information recorded on them.
3. Calculation of distance, area and scale from satellite images and photographs.
4. Introduction to image interpretation using various photo elements.
5. Understand the processing of digital remote sensing data.
6. Introduction to image processing software and its use.
7. Introduction to basics of GIS using GIS software.
8. Field demonstration of GPS (Global Positioning System) and its utility in biodiversity studies.
9. Classification of the provided data and preparation of frequency distribution table.
10. Diagrammatic (Line, bar, pie diagram) and graphic (Histogram, frequency polygon, frequency curve) representation of the data.
11. Determination of Mean, Mode & Median in different data (individual, discrete & continuous data).
12. Determination of Standard Deviation, CV in different data (individual, discrete & continuous data).
13. Test the goodness of fit of the data (Chi Square test).
14. Find out the amount of CO_2 in water sample by Titration method.
15. Find out the amount of DO from water sample by Alsterberg's alkaline sodium azide method.
16. Find out the amount of Cl in water sample by Titration method.
17. Find out the amount of CO_3 and HCO_3 from given water sample by Titration method.
18. Find out the amount of Ca++ and Mg++ from given water sample by Titration method.
19. Find out pH of given water sample by potentiometric method.
20. Study the temperature variations in lotic and lentic water bodies at different depths.
21. Find out the transparency of water by Secchi Disc method.
22. Analyze the water sample for amount of TDS.
23. Analyze the water sample for amount of TSS.
24. Study the macrophytes and write their morphological characteristics.
25. Find out the electrical conductivity of given water sample.
26. Determine the minimum size of the quadrat by species area curve method.
27. Study the community characteristics by quadrat method by determining frequency, density and abundance of different species in the community.
28. Analyse the structure of different Himalayan forests with special emphasis on tree and ground layer.
29. Review and study of various wildlife management plans.
30. Study of nearby Wildlife Sanctuary to study the various conservation and management strategies.