

DEPARTMENT OF
ENVIRONMENTAL SCIENCE
UNIVERSITY OF KASHMIR
SRINAGAR-190006



M.Sc. in Environmental Science

**CHOICE BASED CREDIT SYSTEM COURSE STRUCTURE TO BE
IMPLEMENTED FROM ACADEMIC SESSION 2018 ONWARDS**

**General Course outline and structure of curriculum for Environmental
Science**
1st SEMESTER

| Course | Course Code | Course Name | Paper category | Hours/Week | | | Credits |
|-----------------------------|--------------------|---------------------------|----------------|------------|---|---|---------|
| | | | | L | T | P | |
| Core | ENS18101CR | Components of Environment | Core | 4 | | | 4 |
| | ENS18102CR | Environmental Chemistry | Core | 4 | | | 4 |
| | ENS18103CR | Laboratory Course | Core | | | 8 | 4 |
| Discipline Centric Elective | ENS18104DCE | Environmental Geoscience | DCE | 3 | 1 | | 4 |
| | ENS18105DCE | Environmental Toxicology | DCE | 3 | 1 | | 4 |
| | ENS18106DCE | Mountain Ecology | DCE | 1 | 1 | | 2 |
| | ENS18107DCE | Human and Environment | DCE | 1 | 1 | | 2 |

2nd SEMESTER

| Course | Course Code | Course Name | Paper category | Hours/Week | | | Credits |
|--------|-------------------|---|----------------|------------|---|---|---------|
| | | | | L | T | P | |
| Core | ENS18201CR | Prevention and Control of Environmental Pollution -I | Core | 4 | | | 4 |
| | ENS18202CR | Prevention and Control of Environmental Pollution -II | Core | 4 | | | 4 |

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|------------------------------------|--------------------|--|-------------|----------|----------|----------|----------|
| | ENS18203CR | Biodiversity and Resource Management | Core | 4 | | | 4 |
| | ENS18204CR | Laboratory Course | Core | | | 8 | 4 |
| Discipline Centric Elective | ENS18205DCE | Atmospheric Sciences | DCE | 3 | 1 | | 4 |
| | ENS18206DCE | Environmental Economics and Sustainable Development | DCE | 3 | 1 | | 4 |
| | ENS18207DCE | Green Environment and Ecotourism | DCE | 1 | 1 | | 2 |
| | ENS18208DCE | Ecological Tour | DCE | | | 2 | 2 |

3rd SEMESTER

| Course | Course Code | Course Name | Paper category | Hours/Week | | | Credits |
|------------------------------------|--------------------|---|----------------|------------|----------|----------|----------|
| | | | | L | T | P | |
| Core | ENS18301CR | Natural Resources | Core | 4 | | | 4 |
| | ENS18302CR | Environmental Impact Assessment | Core | 4 | | | 4 |
| | ENS18303CR | Waste Water Engineering | Core | 4 | | | 4 |
| | ENS18304CR | Laboratory Course | Core | | | 8 | 4 |
| Discipline Centric Elective | ENS18305DCE | Environmental Laws and National Policies | DCE | 3 | 1 | | 4 |
| | ENS18306DCE | Environmental Microbiology and Biotechnology | DCE | 3 | 1 | | 4 |
| | ENS18307DCE | Remote Sensing and GIS | DCE | 1 | 1 | | 2 |
| | ENS18308DCE | Ecological Tour (Ladakh) | DCE | | | 2 | 2 |

4th SEMESTER

| Course | Course Code | Course Name | Paper category | Hours/Week | | | Credits |
|------------------------------------|--------------------|--|----------------|------------|----------|-----------|-----------|
| | | | | L | T | P | |
| | ENS18401CR | Project Work | Core | | | 12 | 12 |
| Discipline Centric Elective | ENS18402DCE | Fresh Water Ecology | DCE | 3 | 1 | | 4 |
| | ENS18403DCE | Terrestrial Ecology | DCE | 3 | 1 | | 4 |
| | ENS18404DCE | Environmental Planning and Auditing | DCE | 1 | 1 | | 2 |
| | ENS18405DCE | Restoration Ecology | DCE | 1 | 1 | | 2 |

Course Description 1st Semester CORE COURSES

ENS18101CR: Components of Environment

(04 credits)

Course outcome: The students will be introduced to the basic components and sub-components of Environment and the interactions and interconnectedness therein. Students will be able to identify the nature and level of relationship between various components of the Environment like Atmosphere, Hydrosphere, lithosphere and Biosphere.

Unit I: Atmosphere

- 1.1. Science of the Environment: Scope and relevance
- 1.2. Importance, structure and composition of Atmosphere
- 1.3. Meteorological parameters: Atmospheric pressure, temperature, precipitation, humidity
- 1.4. Wind and atmospheric stability
- 1.5. Radiation and heat budget

Unit II: Hydrosphere

- 1.1. Global Water cycle and water balance concept
- 1.2. Distribution of water on Earth
- 1.3. Components of Hydrosphere
- 1.4. Chemical composition of the Hydrosphere
- 1.5. Cryosphere and climate change

Unit III: Lithosphere

- 1.1. Origin of Earth
- 1.2. Lithosphere: Structure and composition
- 1.3. Rock types and rock cycle
- 1.4. Weathering processes
- 1.5. Mass movement

Unit IV: Biosphere

- 1.1. Origin and evolution of life
- 1.2. Concept and limits of Biosphere
- 1.3. Population Growth and survivorship curves
- 1.6. Structure and function of communities
- 1.5. Interconnectedness of Ecosystems

ENS18102CR: Environmental Chemistry

(04 credits)

Course outcome: This course introduces the students to basic analytical chemistry relevant to the course and is designed to equip the students to handle the instrumentation like Spectrophotometer, AAS, HPLC, GCMS, NMR. Emphasis is laid to have an understanding of the chemistry of atmosphere, water and soil.

Unit I: Analytical chemistry

- 1.1. Basic concepts in analytical chemistry
- 1.2. Spectrophotometry: UV-Visible and AAS,

- 1.3. Chromatography: HPLC, GC-MS
- 1.4. Nuclear magnetic resonance (NMR) and its applications
- 1.5. X-Ray diffraction and FTIR

Unit II: Atmospheric chemistry

- 1.1. Formation and evolution of Earth's atmosphere
- 1.2. Ions, radicals and particulates in the atmosphere
- 1.3. Formation of inorganic and organic particulate matter
- 1.4. Thermo-chemical and photochemical reactions in the atmosphere
- 1.5. Volatile organic compounds (VOCs)

Unit III: Water chemistry

- 1.1. Physico-chemical properties of water
- 1.2. Solubility of gases in water; dissolved gases in water - CO₂, O₂, H₂S, CH₄ and NH₃
- 1.3. Biochemical oxygen demand and chemical oxygen demand
- 1.4. Carbonate-bicarbonate system and redox potential
- 1.5. Nutrients in water: Phosphorus and nitrogen

Unit IV: Soil chemistry

- 1.1. Soil profile and pedogenesis
- 1.2. Inorganic and organic components of soil
- 1.3. Physico- chemical properties of soils
- 1.4. Soil biology
- 1.5. Soil classification and types

ENS18103CR: Laboratory Course

(04 credits)

Course outcome: The students will gain an understanding of various environmental components with much emphasis on water and soil chemistry. Moreover students are expected to learn and perform the experimentation both in field and in the laboratory thereby enriching the skills and professional competency.

Course Contents:

1. Estimation of volume of a water body: Pond, pool, lake
2. Determination of the soil texture in different terrestrial habitats
3. Estimation of meteorological parameters (temperature, precipitation, humidity, wind)
4. Determination of latitude, longitude and altitude of a place
5. Collection and identification of major rock types
6. Determination of light intensity in different habitats
7. Standardization of reagents – titrants (acids, bases)
8. Determination of pH, conductivity, alkalinity, free carbon dioxide and chloride of water samples
9. Estimation of pH, conductivity, alkalinity and chloride content in different soil samples
10. Estimation of cations (calcium, magnesium, sodium, potassium) in water samples
11. Estimation of cations (calcium, magnesium, sodium, potassium) in soil samples
12. Experimental verification of Beer-Lambert's law
13. Determination of primary productivity aquatic and terrestrial habitats

14. Study of dose – response relationships in important toxicants/pollutants
15. Study of leaf pigment by paper chromatography and TLC methods
16. Estimation of protein and carbohydrate content in biological samples
17. Collection and identification of the fish fauna of different aquatic habitats
18. Field visit to IMD for meteorological instrumentation and weather data recording
19. Visit and demonstration of GC-MS and HPLC facility
20. Chemical analysis of rain water

DISCIPLINE CENTRIC ELECTIVE

ENS18104DCE: Environmental Geoscience

(04 credits)

Course outcome: Students will learn the foundation concepts in geoscience. Demonstrate knowledge of geological time and earth's history; and crustal materials and dynamics in context of plate tectonics theory. Gain an understanding of hazard and vulnerability assessments, and its societal relevance. The students will have an insight of marine resource and fundamental concepts in geochemistry.

Unit I: Earth science

- 1.1. Origin and evolution of earth
- 1.2. Geological time scale
- 1.3. Earth surface processes
- 1.4. Geomagnetism: Magnetic and gravitational fields of the earth
- 1.5. Continental drift: Plate tectonics and Neo-tectonics

Unit II: Natural hazards and disaster management

- 1.1. Concept and classification of natural hazards and disasters
- 1.2. Causes and environmental consequences of
 - a. Earth quakes and Tsunami
 - b. Floods and droughts
 - c. Landslides
 - d. Avalanches
- 1.3. Risk assessment and vulnerability analysis
- 1.4. Disaster management: preparedness, response, rehabilitation and failures (case studies)
- 1.5. National and State disaster management policy

Unit III: Marine systems

- 1.1. Marine zones
- 1.2. Composition of seawater
- 1.3. Marine resources
- 1.4. Sea level rise and melting of ice sheets
- 1.5. Ocean conveyor belt**

Unit IV: Geochemistry

- 1.1. Geochemical classification and distribution of elements in earth
- 1.2. Mobility of trace elements
- 1.3. Concept of rare earth elements
- 1.4. Radioactive tracers
- 1.5. Geochemical cycles - C, N, P, S

ENS18105DCE: Environmental Toxicology

(04 credits)

Course outcome:

The students are expected to learn about various types of toxins and the mechanism involved in the bioaccumulation, bio concentration and bio magnification of xenobiotic besides their impact on human health and environment.

Unit I: Principles of toxicology

- 1.1. Definition, scope, goals and divisions of toxicology
- 1.2. Factors influencing toxicity
- 1.3. Dose - response relationship
- 1.4. Toxicological interactions
- 1.5. Toxicity testing methods

Unit II: Biotransformation of xenobiotics

- 1.1. Absorption of xenobiotics, membranous barriers, binding and storage
- 1.2. Excretion of xenobiotics
- 1.3. Biotransformation: General principles and types of biotransformation
- 1.4. Cytochrome P₄₅₀, its variants and their role
- 1.5. Glutathione – S- transferase, its variants and their role

Unit III: Bio-magnification of xenobiotics

- 1.1. Bioaccumulation, bioconcentration and biomagnification - study methods (microcosm)
- 1.2. Compartment models
- 1.3. Bioassay and its applications in toxicology
- 1.4. Antidotal procedures in toxicology
- 1.5. Chemical safety evaluation

Unit IV: Toxicants as public health hazard

- 1.1. Radioactive substances
- 1.2. Food additives
- 1.3. Biological carcinogenesis
- 1.4. Automobile emissions
- 1.5. Occupational diseases: Evaluation and control of occupational health hazards

ENS18106DCE: Mountain Ecology and Resources

(02 credits)

Course outcome: This course is designed to catch an attention of students towards mountain ecosystems which harbour a significant portion of world population. Students will be introduced to the concepts of mountain specific resources especially JK Himalaya which covers reasonable geographical area of Indian Himalayan region, fragility, sustainability besides other issues and challenges related to managing of mountain ecosystems.

Unit I: Mountains ecology

- 1.1. Mountain ecosystem services: Source of Human well being
- 1.2. Drivers of change to Mountain sustainability in Indian Himalayan region
- 1.3. Mountains as early indicators of climate change
- 1.4. Impacts of climate change on mountain ecosystems
- 1.5. Sustainability of Mountain ecosystems: Challenges, opportunities and strategies

Unit II: J&K Himalayan resources

- 1.1. Glacier and water resources
- 1.2. Forests resources
- 1.3. Agricultural resources
- 1.4. Flora and fauna of Jammu & Kashmir
- 1.5. Energy resources of Jammu & Kashmir (Hydel)

ENS18107DCE: Human, Environment and Development

(02 credits)

Course outcome: In this course students will learn about proximate drivers of economy's and life style change impact on environmental quality. Further they will get familiar with the role of various stake holders in protecting the quality of environment from further degradation. This paper takes the students to social thought on environmental issues from a historical and contemporary perspective.

Unit I: Environmentalism

- 1.1. Environmentalism: Concept and history
- 1.2. Environmental organizations (WWF, UNEP, IUCN, WHO)
- 1.3. Environmental justice
- 1.4. The monetization frontier
- 1.5. Environmental politics

Unit II: Environmental education

- 1.1. Environmental education: Aims, objectives and principles
- 1.2. Environmental protection and religious teachings
- 1.3. Environmental literacy and activism
- 1.4. Environmental ethics
- 1.5. Environmental policy and public attitude

Course Description 2nd Semester

CORE COURSES

ENS18201CR: Prevention and Control of Environmental Pollution – I

(04 credits)

Course outcome: The students in this course will be provided a comprehensive picture of pollution scenario especially air and radiation pollution and its likely impact of pollutants on the environment. Students will be able to achieve the competence in the area of prevention and control measures of various types of pollution like air, noise and electromagnetic.

Unit I: Air pollution

- 1.1. Sources, classification and properties of primary and secondary air pollutants
- 1.2. Impact of air pollution on human health and environment
- 1.3. Smog and acid rain

- 1.4. Ozone layer depletion
- 1.5. Global warming and climate change

Unit II: Control of air pollution

- 1.1. Indoor air pollution and its control: smoke, HCs, particulate matter, radon
- 1.2. Air quality standards and monitoring of air pollution: SO_x, NO_x, CO, SPM and hydrocarbon
- 1.3. Control of particulate and gaseous air pollution - SO_x, NO_x, CO
- 1.4. Control of greenhouse gases
- 1.5. Bio-filters for control of air pollution / Air pollution act

Unit III: Noise pollution and its control

- 1.1. Noise pollution: definition and sources
- 1.2. Measurement of noise levels
- 1.3. Equivalent sound pressure level (Leq), noise pollution level (NPL), sound exposure level (SEL), traffic noise index (TNI), day-night level (DNL), noise criteria curves.
- 1.4. Impact of noise on human health and environment
- 1.5. Noise control and abatement measures

Unit IV. Electromagnetic and Electronic Pollution

- 1.1. Electromagnetic Pollution and types of electromagnetic fields (EMFs)
- 1.2. Electromagnetic Pollution in Outdoor Environment
- 1.3. Electromagnetic Pollution in Indoor Environment
- 1.4. Radiation exposure and impact on Human Health
- 1.5. E-Waste management rules, 2016

ENS18202CR: Prevention and Control of Environmental Pollution – II (04 Credits)

Course outcome: Land and water pollution forms a core area of environmental science wherein the students in this course will get an insight regarding a comprehensive picture of water and land pollution scenario and its associated costs on the environment. Students are expected to achieve the technical competence in monitoring the various types of pollutants in the water and soil environment.

Unit I: Land degradation and soil pollution

- 1.1. Land degradation and soil pollution: causes and types
- 1.2. Desertification: causes, consequences
- 1.3. Soil erosion: causes, assessment and environmental impacts
- 1.4. Impact of pesticides in soil
- 1.5. Industrial waste effluents and their interaction with soil components

Unit II: Control of land degradation and soil pollution

- 1.1. Control of soil pollution
- 1.2. Soil conservation and control of soil erosion
- 1.3. Waste lands and their reclamation
- 1.4. Sustainable agricultural practices
- 1.5. Integrated pest management

Unit III: Water pollution

- 1.1. An overview of water pollution scenario and public health
- 1.2. Lake eutrophication and stream pollution
- 1.3. Petroleum hydrocarbons and marine pollution
- 1.4. Ground water and Thermal pollution
- 1.5. Biocides and heavy metals: impact on public health and aquatic life

Unit IV: Prevention and Control of water pollution

- 1.1. Control of eutrophication and restoration of lakes and wetlands
- 1.2. Role of microbes and aquatic plants in pollution abatement
- 1.3. Control of Stream and groundwater pollution
- 1.4. Bio monitoring of water quality: Water quality and Biotic indices
- 1.5. The Water (Prevention and Control of Pollution) Act (1974)

ENS18203CR: Biodiversity and Resource Management

(04 credits)

Course outcome

This course will enable the students to have an understanding on wealth of biodiversity in various geographical regions apart from management and conservations thereof.

Unit I: Biogeography

- 1.1. Geographical classification and zones
- 1.2. Major biomes of the world: Distribution and characteristic features
- 1.3. Zoogeographic realms of the world: Palaearctic, nearctic, neotropical, oriental, australian and african
- 1.4. Dispersal: Means, modes and barriers, island life
- 1.5. Migrations

Unit II: Biodiversity

- 1.1. Biodiversity: Status and importance, India as a mega-diversity nation
- 1.2. Endemism: Factors controlling distribution of flora and fauna
- 1.3. Hot Spots and cold spots, concept of native and exotic species
- 1.4. Biodiversity decline: Drivers of change and pressures
- 1.5. Threatened species categories of IUCN; concept of extinction threshold and extinction debt

Unit III: Biodiversity Management

- 1.1. Forest conservation: social forestry and joint forest management
- 1.2. Management of rangelands
- 1.3. Fishery resource management
- 1.4. Monitoring and management of bio-diversity
- 1.5. Biodiversity Conservation
 - a. In-situ conservation: National parks, sanctuaries, biosphere reserves, Ramsar Sites
 - b. Ex-situ conservation: botanical gardens, zoological parks, zoos, seed banks, in-vitro conservation

Unit IV: Management of natural resources

- 1.1. Concept and strategies of sustainable development
- 1.2. Management of mineral resources
- 1.3. Management of fresh water resources
- 1.4. Energy crisis and conservation of energy resources

1.5. Concept of ecological footprint and carbon sequestration

ENS18204CR: Laboratory Course

(04 credits)

Course outcome: This course is structured in such a way that the students should learn and attain a practical exposure of monitoring and analysis of air, water, noise and ecological samples which will enhance the marketability of students in employment. This course is also designed to cater the demand of various Govt and Non Govt agencies for environmental analysts.

Course Contents

1. Estimation of rate of flow of water and determination of silt load of a stream / river
2. Estimation of total dissolved and suspended solids in water
3. Determination of rate of soil erosion in different ecosystems
4. Estimation of dissolved oxygen, BOD and COD in different waters
5. Estimation of organic carbon and organic matter in different soils samples
6. Estimation of nitrogen (NH₃, NO₂ and NO₃) and phosphorus (ortho and total) in different water samples
7. Estimation of phosphorus and nitrogen content in different soil samples
8. Estimation of dissolved silica and sulfate in different water bodies
9. Determination of SO_x, NO_x and particulate matter (PM) in ambient air
10. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
11. Study of ambient noise levels in different zones
12. Qualitative and quantitative estimation of phytoplankton community in different aquatic habitats
13. Qualitative and quantitative estimation of periphyton community in different aquatic habitats
14. Application of diversity indices in aquatic and terrestrial ecosystems
15. Biochemical tests for different enzymes
16. Preparation of bacterial smears and gram staining
17. Estimation of bacterial population in different water samples by culture technique
18. Estimation of fungal population in different habitats through culture techniques
19. Phytosociological analysis of plant community in the field
20. Visit to a National park/ wild life sanctuary

DISCIPLINE CENTRIC ELECTIVE

ENS18205DCE: Atmospheric Science

(04 credits)

Course outcome: To make students aware of basic concept in atmospheric science. Teach them various climatic patterns and their impact on air pollution. To comprehend weather patterns and the processes that cause them and to impart understanding of atmospheric data analysis using various meteorological instruments and observation methods.

Unit I: Climatology

- 1.1. Fundamentals of climatology
- 1.2. Classification of climate: Koppen's and Trewartha
- 1.3. Monsoon and climatic zones of India

- 1.4. Western disturbances and climate of J&K
- 1.5. Paleo-climatology and climate change

Unit II: Atmosphere circulation

- 1.1. Introduction to atmospheric science and air sea interactions.
- 1.2. Basic structure and mechanism: Atmospheric general circulation
- 1.3. Basic structure and mechanism: Ocean general circulation
- 1.4. Climate variability and forcing: Madden Julian oscillations (MJO), El-nino and southern oscillations (ENSO), Indian Ocean dipole (IOD)
- 1.5. Climate modelling

Unit III: Atmospheric aerosols

- 1.1. Introduction and types of aerosols
- 1.2. Sources, transformation, geographical distribution and atmospheric effects
- 1.3. Chemical composition of aerosols
- 1.4. Carbonaceous aerosols: Black carbon
- 1.5. Global cooling versus global warming

Unit IV: Atmospheric data analysis

- 1.1. Dry and wet atmospheric deposition
- 1.2. LIDARS, SODARS, weather RADARS
- 1.3. Remote-sensing techniques (WP-RASS)
- 1.4. Self recording instruments, radiosondes, radiometersondes, ozone sonde
- 1.5. Satellite meteorology: visible and infrared radiometer and multi scanner radiometer

ENS18206 DCE: Environmental Economics and Sustainable Development (04 credits)

Course outcome: In this course students will learn how economic activity depends upon and affects the natural environment. The students will be exposed to the idea and argument that the environment sets the limits to the economic growth thereby setting the context and tone for the emergence of the idea of sustainable development. Further students will also get the understanding of various types of services provided by the nature free of any cost.

Unit I: Environmental economics

- 1.1. Environmental economics: Definition and scope
- 1.2. Economic growth versus sustainable development
- 1.3. Concept of intangibles and externalities
- 1.4. Environmental evaluation methods: Hedonic pricing, contingent evaluation and Household production function
- 1.5. Carbon credits and trading

Unit II: Environment and Development

- 1.1. Sustainability and pillars of sustainability
- 1.2. Sustainability and the green footprint
- 1.3. Sustainable development goals
- 1.4. World Summit on sustainable development

1.5. World Environment views

Unit III: Population and Development

- 1.1. Global population patterns and trends
- 1.2. Understanding population growth rates
- 1.3. Population, poverty and resource utilization
- 1.4. Resource conflicts: Extraction, access and control
- 1.5. Linkages between environment population and development

Unit IV: Ecosystem Services

- 1.1. Ecology and Ecosystems: Moving towards sustainability
- 1.2. Typologies of ecosystem services
- 1.3. Biodiversity: Engine of ecosystem services
- 1.4. Valuation and accounting of Ecosystem services
- 1.5. Incentives for Ecosystem services (IES) in the Himalayas

ENS18207DCE: Green Environment and Ecotourism

(02 Credits)

Course outcome: The students will understand the importance and the underlying principles of green and sustainable technology. This course will improve the understanding of operational performance, productivity or efficiency, while reducing costs, inputs, energy consumption, waste and pollution.

Unit I: Green cities

- 1.1. Concept of green buildings and cities
- 1.2. LEED (Leadership in Energy and Environmental Design) certified buildings
- 1.3. National Mission for a Green India
- 1.4. Eco-mark certification
- 1.5. Life cycle assessment (LCA)

Unit II: Ecotourism

- 1.1. Ecotourism: concept, significance and strategies
- 1.2. Tourism in National Parks, sanctuaries, wetlands and other landscapes
- 1.3. Concept of tourism carrying capacity
- 1.4. Tourism policy
- 1.5. Ecotourism potential in J&K

ENS18208DCE: Ecological Tour

(02 credits)

Course outcome: Students in this course are supposed to visit important subtropical and tropical habitats of the country besides the institutions/Research Centres/Universities so as to gain knowledge, understanding and experience about the natural resources, educational institutions and research facilities in the country. Students have to submit the tour report and collection if any for evaluation by external examiner. One credit will be given for participation and one credit for Tour report and viva voce.

Course Description 3rd Semester

CORE COURSES

ENS18301CR: Natural Resources

(4 credits)

Course outcome: The students will be able to critically evaluate current status related to natural resources as being scientifically-based or opinion-based and contribute to the knowledge base of information. The students will also gain an insight of means to control exploitation of resources to maintain a balance between man and nature.

Unit I: Mineral resources

- 1.1. Classification of mineral resources
- 1.2. National mineral policy, 2019
- 1.3. Mineral resources in India with special reference to J&K
- 1.4. Global mineral distribution in oceans
- 1.5. Environmental impact of mineral resource exploitation, exploration, mining, processing and post-processing scenarios.

Unit II: Water resources

- 1.1. Global water situation- A snapshot
- 1.2. Global water foot print
- 1.3. Water resources of India with special reference to Kashmir
- 1.4. Water security: Challenges and opportunities
- 1.5. Water and food security linkage

Unit III: Bio-resources

- 1.1. Animal resources: current status with special reference to India
- 1.2. Fishery resources of India with special reference to J&K
- 1.3. Plant resources
- 1.4. Forest resources of India: Timber and non-timber
- 1.5. Rangelands

Unit IV: Energy resources

- 1.1. Renewable energy resources
- 1.2. Non-renewable energy Resources
- 1.3. Nuclear energy
- 1.4. Concept of green fuels
- 1.5. Hydrogen as a source of energy

ENS18302CR: Environmental Impact Assessment

(04 credits)

Course outcome: The students completing the course will have ability to carry out scoping and screening of developmental projects for environmental and social assessments, explain different

methodologies for environmental impact prediction and assessment, plan environmental impact assessments and environmental management plans and evaluate environmental impact assessment reports.

Unit I: Fundamentals of EIA

- 1.1. Environment impact assessment: Concept and objectives
- 1.2. EIA process
- 1.3. Impact evaluation and prediction
- 1.4. EIA guidelines 2006 and amendments
- 1.5. Environment Protection Act and Rules, 1986

Unit II: EIA methodologies

- 1.1. Protocol for EIA
- 1.2. EIA methods
- 1.3. Air and water quality assessment
- 1.4. Ecological and social impact assessment
- 1.5. Cost benefit analysis.

Unit III: Strategic Environmental Assessment

- 1.1. SEA: Concept and process
- 1.2. Case studies of EIA (Hydro power and Town Area Development)
- 1.3. Case studies of SEA (Hydropower and Industrial Estate)
- 1.4. Risk assessment
- 1.5. Risk characterization and management

Unit IV: Ecological modeling

- 1.1. Basic concepts and perspectives in modelling
- 1.2. Linear, simple and multiple regression models
- 1.3. Model validation and forecasting
- 1.4. Models of population growth and interactions: Lotka-Volterra model and Leslie's matrix model.
- 1.5. Models of pollution dispersion: Gaussian plume model.

ENS18303CR: Waste Water engineering

(04 credits)

Course outcome: This course is framed to give the basic understanding of waste waters and application of theoretical principles and processes for waste water treatment by the visits to the Sewage Treatment Technology facilities. Design and working of STP is taught through the intensive field visits. This course has also potential to provide a good technical human resource to cope up with the ever increasing challenge of managing the waste water.

Unit I: Fundamentals of waste water engineering

- 1.1. Waste water Engineering: An overview
- 1.2. Constituents of concern in waste water treatment
- 1.3. Characteristics of diverse constituents: Physical, metallic, nonmetallic, organic and Biological
- 1.4. Health and Environmental concerns in waste water management
- 1.5. Waste water treatment: Methods, current status, new directions and future trends

Unit II: Fundamentals of biological treatment

- 1.1. Overview and objectives of Biological waste water treatment
- 1.2. Types of Biological processes and role of microbes in waste water treatment (WWT)
- 1.3. Composition and classification of microbes in WWT
- 1.4. Introduction to microbial metabolism
- 1.5. Microbial growth kinetics

Unit III: Suspended growth biological treatment processes (BTP)

- 1.1. Introduction and evolution of activated sludge process
- 1.2. Biological Nitrification and denitrification
- 1.3. Biological phosphorus removal
- 1.4. Biological removal of toxic and recalcitrant organic compounds
- 1.5. Biological removal of heavy metals

Unit IV: Attached growth, advanced waste water treatment and disinfection processes

- 1.1. Evolution of attached growth processes
- 1.2. Trickling filter and RBC
- 1.3. Membrane filtration process, adsorption, gas stripping, ion exchange and distillation
- 1.4. Overview of disinfection theory: methods and means
- 1.5. Application of various disinfectants: Characteristics, chemistry, merits and demerits

ENS18304CR: Laboratory Course

(04 credits)

Course outcome: The students will get empirical inputs of fundamental remote sensing and EIA. The students will also be able to statistically analyze and interpret laboratorial results. Furthermore, collection and field trips will help the students to get firsthand experience with the nature.

Course Contents

1. Survey of different residential areas for determining the prevalence of different air, water, soil and food borne diseases
2. EIA – Leopold Matrix method and case studies
3. Socio-economic studies – preparing of questionnaire and case studies
4. Computation of standard deviation, standard error and coefficient of variation
5. Computation of correlation and regression
6. One way and two way classification of ANOVA
7. Land use / land cover classification from satellite data
8. Delineation of drainage of a given area from satellite data
9. Delineation of point, line and polygon themes
10. Waste auditing of any institution/ organization
11. Working and design of sewage treatment plants and Jar test
12. Spring and stream order classification
13. Study of colonization potential of periphyton on artificial substrates
14. Study of morphogenetic response of explants on media
15. Collection and demonstration of the pharmacognostic characters of important medicinal plants
16. Comparative anatomical study of mesophytes, hydrophytes and xerophytes

17. Collection and identification of common aquatic macrophytes
18. Field trip to National park/wildlife sanctuary/industrial area /Hydropower project
19. Study of insect fauna in different environments
20. Morphometric and bathymetric survey of a lake or pond

DISCIPLINE CENTRIC ELECTIVE

ENS18305DCE: Environmental Laws and National Policies (04 credits)

Course outcome: This course is framed in such a way that students of environmental science should be aware of the legal perspective on various issues and dimensions of environment. They will get a better understanding about the situation whether there is matching response from the legal and policy front of the nation towards the ever increasing environmental degradation.

Unit I: Environmental Protection

- 1.1. Environment protection: Provisions of constitution (article 21,48A, 51A, and 253)
- 1.2. National efforts on environmental protection, laws and policy in India
- 1.3. International efforts for environment protection (Stockholm, Kyoto protocol, Paris agreement)
- 1.4. CITES (1973)
- 1.5. Earth Summit

Unit II: National Laws-I

- 1.1. Indian forest act (1927), forest conservation Act (1980) and rules (1981)
- 1.2. Wildlife protection Act (1972) and amended (2002) and J & K wildlife (protection) Act (1978) as amended in (2002)
- 1.3. Biological diversity Act (2002) and National green tribunal act (2010)
- 1.4. Public liability insurance act (1991)
- 1.5. Intellectual property rights and patent act (2005)

Unit III: National Laws-II

- 1.1. Hazardous waste management and handling rules (1989)
- 1.2. Biomedical waste (management and handling) rules (1998)
- 1.3. Noise pollution (regulations and control) rules (2000)
- 1.4. Municipal solid wastes (management and handling) rules (2000)
- 1.5. Plastic management rules, 2016

Unit IV: National Policies

- 1.1. National Forest Policy, 2018
- 1.2. National Environmental Policy, 2006
- 1.3. National Water Policy, 2012
- 1.4. National Energy Policy, 2017
- 1.5. Nation action plan on Climate change (NAPCC)

ENS18306DCE: Environmental Microbiology and Biotechnology (04 credits)

Course outcome: This course is designed with the aim to study the importance of microorganisms in the establishment of life on earth, distribution of microorganisms in different habitats like soil, water air, extraterrestrial environments and methods to study them. It also deals with the ways these microorganisms can be motivated and manipulated for remedifying the environmental issues, extraction of valuable substances, and conversion of waste to wealth.

Unit I: Microbes and environment

- 1.1. Nature and function of micro-organisms in the environment (soil, water and air)
- 1.2. Role of microbes in fixation and solubilization / mineralization of nutrients: carbon, nitrogen, phosphorus and sulphur
- 1.3. Microbial spoilage of food and its preservation
- 1.4. Bio-deterioration of materials and control
- 1.5. Application of micro-organisms in the control of
 - a. Oil pollution
 - b. Chemical pollution - pesticides, synthetic polymers, and metals

Unit II: Microorganisms and human health

- 1.1. Human health and environment: MMR, IMR, Life expectancy, morbidity
- 1.2. Status of communicable diseases in India
- 1.3. Epidemiology (reservoir of infection, communicability and control) of major air, soil, water and food borne diseases
- 1.4. Allergic diseases
- 1.5. Insect vectors of human diseases like malaria, dengue, encephalitis, and their control

Unit III: Applied environmental biotechnology

- 1.1. Biodegradation and bioremediation
- 1.2. Conversion of Waste into wealth (biocomposting and biogas production)
- 1.3. Biofuels and biomining (A replacement to petroleum pollution)
- 1.4. Bioindicators and biosensors in environmental biomonitoring
- 1.5. Ecofriendly approach of Biofertilizers

Unit IV: Environmental Genomics & Applications

- 1.1. Biotechnology in pollution Control
- 1.2. Environmental genomics: A key concept of e-DNA
- 1.3. Metagenomics: environmental applications
- 1.4. Genetically modified organisms and biosafety: An account
- 1.5. Bioprospecting: Use of Microbial enzymes

ENS18307DCE: Remote Sensing and GIS (02 credits)

Course outcome: To impart knowledge to students of basic principles of remote sensing and Geographic information system. To explain concepts, methods and techniques relevant for geoinformation processing and earth observation.

Unit I: Remote-sensing

- 1.1. Concept and overview of remote sensing: Concept of resolution-spatial, spectral, radiometric and temporal
- 1.2. Remote Sensing satellites: LANDSAT & IRS satellite series
- 1.3. Electromagnetic spectrum: EMR sources-active & passive, radiation laws
- 1.4. Fundamentals of image processing and interpretation
- 1.5. Aerial photographs

Unit II: Geographic information system

- 1.1. GIS: history and development, Functional requirements: Hardware configuration, software modules
- 1.2. Geographic data: Spatial and non-spatial, data models: raster and vector
- 1.3. Global positioning system : Basic principles and functioning
- 1.4. Remote sensing and GIS integration
- 1.5. Application of remote sensing and GIS in:
 - a. Agriculture and Forestry
 - b. Water resource management
 - c. Environmental impact assessment

ENS18308DCE: Ecological Tour to Ladakh

(02 credits)

During 3rd semester, students will be required to go for the field study tour within Jammu & Kashmir carrying 02 credits which will form a component of the elective allied. One credit will be given for participation and one credit for field collection, tour report and viva-voce.

Course Description 4th Semester

CORE COURSE

ENS18401CR: Project Work

(12 credits)

Course outcome: The project work shall be of practical/survey based and is intended to inculcate the research aptitude among students to carry out the research on various pressing environmental issues. This is one of the best practice in the department to prepare the students and give them early exposure to work on the minor research problem. This will further provide conducive atmosphere and platform for writing the research proposals and articles. Each student has to submit the dissertation of the project work for evaluation. The student has to give seminar (internal) and viva voce (external) of the project work before external examiner.

DISCIPLINE CENTRIC ELECTIVE

ENS18402DCE: Freshwater Ecology

(04 credits)

Course outcome: As is true of all organisms, our very existence depends on water and we need an abundance of fresh water to live. This course will enable the students to get a better picture on the status of aquatic systems and the interactions involved. Further, it may also equip the students for understanding the management and restoration of aquatic systems.

Unit I: Freshwater ecosystems

- 1.1. Water has a human resource
- 1.2. Aquatic ecosystem services and aesthetic values of lakes and rivers
- 1.3. Paleolimnology
- 1.4. Trophic dynamics in aquatic ecosystems
- 1.5. Endemism in aquatic systems and urban ecosystems

Unit II: Stream and river ecology

- 1.1. Concepts in stream ecology and stream classification
- 1.2. Streams and rivers as ecosystems
- 1.3. Chemical fluxes and nutrient dynamics in river and stream ecosystems
- 1.4. Aquatic insects ecology and feeding in streams and rivers
- 1.5. Concept and importance of riparian zones

Unit III: Lakes and wetland ecology

- 1.1. Ecology of lakes and wetlands: Global distribution and classification systems
- 1.2. Macrophytes: classification and zonation
- 1.3. Mixing dynamics in lakes across climatic zones
- 1.4. Effect of climate change on lakes and wetlands
- 1.5. Important lakes and wetlands of J&K

Unit IV: Freshwater Biodiversity

- 1.1. Measures of diversity
- 1.2. Factors influencing the evolution and distribution of organisms
- 1.3. Invasion of non- native species
- 1.4. Values of freshwater biodiversity
- 1.5. Stream biofilm composition

ENS18403DCE: Terrestrial Ecology

(04 credits)

Course outcome: Understanding the structure and function of terrestrial ecosystems is fundamental to their conservation and necessary for remediation of impacted environments. This course provides a conceptual framework for understanding the range of the world's terrestrial ecosystems. Examine the principles and theories on the relationships between terrestrial life and

both biotic and abiotic factors in the environment. This course also enables students to learn and explain how landscape characteristics and patterns influence species distribution.

Unit I: Terrestrial ecosystems

- 1.1. Ecosystem structure and processes
- 1.2. Terrestrial water and energy balance
- 1.3. Terrestrial production
- 1.4. Terrestrial decomposition
- 1.5. Carbon sequestration potential of terrestrial ecosystems

Unit II: Landscape ecology

- 1.1. Concept of landscape ecology
- 1.2. Tools in landscape ecology
- 1.3. Causes of landscape pattern
- 1.4. Application of landscape ecology
- 1.5. Landscape management

Unit III: Forest and agro-ecology

- 1.1. Forest community structure and function
- 1.2. Theory and practice of managing the establishment, composition, and development of the forest
- 1.3. Urban forest ecology
- 1.4. Agro-ecosystems: Concept, structural and functional components
- 1.5. Role of biodiversity in agro-ecosystems, Food security and agriculture

Unit IV: Desert and grassland ecology

- 1.1. Ecological complexity of the desert communities
- 1.2. Fauna and flora of the deserts
- 1.3. The Cold Desert: Ladakh
- 1.4. Grasslands ecology: evolution and types
- 1.5. Biodiversity and conservation in grasslands

ENS18404DCE: Environmental Planning and Auditing

(02 credits)

Course outcome: The curriculum is specially designed to train the students in methods of scientific analysis and evaluation of the various developmental projects and its effect on the environment. The students are made aware of environmental considerations at the planning stage that prevent environmental degradation later on. The students can evaluate how well the environmental management information system are well equipped to and performing and verily compliance with the relevant national and local and other laws and regulations. They are educated to minimize human exposure to risk from environmental health and safety problems.

Unit I: Environmental Planning

- 1.1. Environmental planning – importance and objectives
- 1.2. Land use planning
- 1.3. Urban and rural development and environmental planning
- 1.4. Integrating Biophysical and Economic Information to Guide Land Conservation Investments

1.5. Role of ethics, aesthetics and science in environmental planning

Unit II: Environmental Auditing

1.1. Principles and guidelines of environmental auditing

1.2. Preparation of environmental audit report

1.3. Waste audit procedures – sources, types and management of wastes

1.4. ISO 9001 and 9002

1.5. ISO 14000

ENS18405DCE: Restoration Ecology

(02 credits)

Course outcome: On successful completion of the course students will be able to understand the underlying principles and theories, current practices and issues in restoration ecology. Understand the need for adaptive management, and how this may be applied, by participating in a local community restoration experiment. This course enables students to critically analyze theory and techniques and apply them to the problem of restoring a degraded ecosystem.

Unit I: Concepts in restoration ecology

1.1. The basic principles and concepts of restoration ecology

1.2. Characteristics of degraded and restored ecosystems

1.3. Ecological indicators in restoration

1.4. Theory and practice of restoring animal and plant diversity

1.5. Case studies in restoration ecology

Unit II: Restoration planning

1.1. Goals and objectives

1.2. Adaptive management and monitoring

1.3. Ethics of restoration

1.4. Role of public-private partnership in restoration

1.5. Major constraints in progress and success of restoration programs

**DEPARTMENT OF
ENVIRONMENTAL SCIENCE
UNIVERSITY OF KASHMIR
SRINAGAR-190006**



M.Sc. in Environmental Science

**CHOICE BASED CREDIT SYSTEM COURSE STRUCTURE TO BE
IMPLEMENTED FROM ACADEMIC SESSION 2018 ONWARDS**

Generic Elective and Open Elective course outline

| Course | Course Code | Course Name | Paper category | Hours/Week | | | Credits |
|------------------|-------------|------------------------------------|----------------|------------|---|---|---------|
| | | | | L | T | P | |
| Generic Elective | ENS18001GE | Basics of Ecology and Environment | GE | 1 | 1 | | 2 |
| | ENS18002GE | Environmental Issues | GE | 1 | 1 | | 2 |
| Open Elective | ENS18003OE | Environmental Ethics and Sociology | OE | 1 | 1 | | 2 |
| | ENS18004OE | Environmental Protection | OE | 1 | 1 | | 2 |

COURSE DESCRIPTION GENERIC ELECTIVE

ENS18GE01: Basics of Ecology and Environment

(2 credits)

Course outcome: The students will gain an insight on basic understanding of ecosystem dynamics. This course is framed keeping in view the heterogeneity of the students coming from diverse backgrounds.

Unit I

- 1.1 Importance of environment
- 1.2 Components of environment-Atmosphere, hydrosphere, lithosphere and biosphere
- 1.3 Human and environment relations
- 1.4 Environment and development
- 1.5 Tools for environmental management

Unit II

- 1.1 Structure and functions
- 1.2 Natural and managed ecosystem
- 1.3 Ecosystem goods and services
- 1.4 Ecological Succession
- 1.5 Ecological Interactions understanding of ecosystem dynamics.

ENS18GE02: Environmental Issues

(02 credits)

Course outcome: This course enables students to understand the trans-boundary character of environmental problems and ways of their management including prevention and control strategies. The course enables to apply system concepts and methodologies to appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

Unit I

- 1.1. History and nature of human population growth
- 1.2. Natural resources, current status and types of resources
- 1.3. Resource depletion
- 1.4. Environment and human health
- 1.5. Environmental degradation

Unit II

- 1.1 Air pollution
- 1.2 Water pollution
- 1.3 Soil Pollution
- 1.4 Noise pollution
- 1.5 Radioactive pollution

COURSE DESCRIPTION OPEN ELECTIVE

ENS18OE01: Environmental Ethics and Sociology

(2 Credits)

Course outcome: The course is designed to give emphasis on teaching of humanities and social sciences for the overall intellectual and social development of the students. This course intends to expand the students' horizon of knowledge by exposing them to areas of study which make them sensitive to a wide range of human problems and social phenomena. Such a holistic education, it is hoped, would enable them to appreciate their role in national reconstruction by responding to the challenges of the time.

Unit I

- 1.1. An introduction to environmental ethics and philosophy
- 1.2. Ethics in society
- 1.3. Responsibility for environmental degradation
- 1.4. Theories of environmental ethics and philosophy
- 1.5. Resource consumption patterns and the need for equitable utilization

Unit II

- 1.1. Role of agriculture in socio-economic development
- 1.2. Land reforms and Bhoodan movement in India
- 1.3. Community development projects
- 1.4. Rural social structure
- 1.5. Ecological theories of urbanization and urban social problem

ENS18OE02: Environmental Protection

(02 Credits)

Course outcome: The objective of this paper is to familiarize the students with the environmental issues, pollution and control and the measures taken for its protection along with the norms prevailing at international and national level. Students will be able to get basic knowledge of environment, pollution and various principles. They will also gain an insight about constitutional provisions for the protection of environment. This course enables students to learn about the legal provisions of the water pollution, the air pollution, and Environment (protection) Act, powers of central government and state government to make laws and Environment Tribunals.

Unit I

- 1.1. Role of an individual in conservation of natural resources
- 1.2. General idea about environmental laws
- 1.3. International conventions (Stockholm declaration)
- 1.4. Kyoto protocol and Montreal protocol
- 1.5. Earth summit

Unit II

- 1.1. Environment management
- 1.2. Control of soil, water and air pollution
- 1.3. Solid and hazards waste management
- 1.4. Biodiversity conservation
- 1.5. Natural resource management