

DEPARTMENT OF
ENVIRONMENTAL SCIENCE
UNIVERSITY OF KASHMIR
SRINAGAR-190006



M.Sc. in Environmental Science

**CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE
IMPLEMENTED FROM ACADEMIC SESSION 2015-16**

The revised syllabi and courses of study for Post-graduate programme in Environmental Science will be based on 96 credits (average of 24 in each semester). All the 96 credits will spread over 5 different components viz. - (i) teaching, (ii) tutorial, (iii) seminar, (iv) three laboratory courses (one each in the first, second and third semester), and (v) project work (dissertation) in fourth semester. Each semester will consist of at least 24 credits including 12 core credits (compulsory), 12 discipline centric elective (maximum of 6 credits to be opted) and 6 general and open elective credits for the students of other department of the university.

Course Structure: There will be 12 core courses (theory and lab.) in all with each semester covering 3 core courses referred as **ENS-CR**. Each core course will be worth 4 credits with theory covering 8 credits and practical component 4 credit. There will be Discipline Centric Elective (DCE) courses (mainly for Department's own students) worth 4 and 2 credits referred to as **ENS-DCE**. Students can opt for 2 courses to earn 6 credits or at least one course each to earn minimum of 2 or 4 credits. Further, in addition to **CR** and **DCE** courses there will be General Elective courses referred to as **ENS-GE** which will be open to students from other sister subjects (Biological, Physical and Material Science) and Open Elective courses referred to as **ENS-OE** which will be open to students from all the faculties (Science, Social Science, Arts, Commerce etc) so that they seek knowledge from unrelated subject which will nurture student's proficiency and /skill. The total course of M. Sc. Environmental Science comprises of **96 credits out of which 48 are core while other credit combination could be as under.**

Credits	Core	DCE	GE	OE	Total
Minimum Credits	12	2-6	2-4	2-6	20
Average Credits	12	6	0-6	0-6	24
Maximum Credits	12	6	0-14	0-14	32

Each **CR** course will be worth of 100 marks and 4 credits comprising of **internal assessment of 20 marks** and **external examination of 80 marks**. Internal assessment of theory papers will be based on quiz tests/assignments/seminars, etc. The practical component will also be of internal assessment comprising 20 marks based on student's performance during practical periods and external examination of 80 marks through conduct of common test at the end of each semester to finalize awards for the same. The students will be required to submit their lab. work records at the end of each semester examination for evaluation by the examiner/teacher(s) concerned.

The **DCE course** will be worth **100 marks for 4 credits courses** and **50 marks for 2 credit courses**. For 4 credits courses, 80 marks will be for theory and 20 will be for tutorials. In theory 20 marks will be for internal assessment and 60 mark for external examination. For 2 credits courses, 40 marks will be for theory and 10 will be for tutorials. In theory 10 marks will be for internal assessment and 30 mark for external examination.

Each **GE and OE course** will be worth **50 marks (2 credits)**. Out of these, 40 marks will be for theory and 10 for tutorials. In theory 10 marks will be for internal assessment and 30 marks for external examination.

ENS-DCE, ENS-GE and ENS-OE will be floated as semester courses wherein the selection will be based on the choice of the teacher concerned in terms of feasibility/availability as well as number of vacancies available based on the choice of the concerned teacher. However, on the basis of the recommendations of Departmental Committee minimum number of seats under these courses should not be less than 4 for DCE, GE and OE respectively in any such course.

Project work: Project work (**ENS-CR**) worth **4 credits** is compulsory for the students and will be assigned in **4th semester** based on choice of the student and space availability in relation to his/her choice. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and viva voce be conducted prior to declaration of the results. The students for project work will be evenly distributed among faculty members of the Department.

Ecological Tours: To make on-field observations and impart on-site training in the subject, the students are required to go for ecological tours organized during **2nd semester** (outside state) and **3rd semester** (within state) carrying **2 credits** and will form a component of **DCE**. One credit will be given for participation and one credit for tour report and viva voce verified by examiner.

In the Table below the terms refer to:

L	– Lecture
T	– Tutorial;
P	– Practical Work;
CR	– Core Course;
DCE	- Discipline Centric Elective
GE	- General Elective
OE	- Open Elective

General course outline for two years program for four semesters**1ST SEMESTER**

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	ENS101CR	Fundamentals of Environmental Science	Core	4			4
	ENS102CR	Environmental Chemistry	Core	4			4
	ENS103CR	Laboratory Course	Core			8	4
Discipline Centric Elective	ENS104DCE	Environmental Geosciences	DCE	3	1		4
	ENS105DCE	Environmental Toxicology	DCE	3	1		4
	ENS106DCE	Mountain Ecology	DCE	1	1		2
	ENS107DCE	Human and Environment	DCE	1	1		2
Generic Elective	ENS108GE	Plant Morphogenesis & Regeneration	GE	1	1		2
	ENS109GE	Genotoxicity	GE	1	1		2
Open Elective	ENS110OE	Environmental Ethics and Sociology	OE	1	1		2
	ENS111OE	Basics of Ecology and Environment	OE	2	1		3

2nd SEMESTER

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	ENS201CR	Environmental Pollution and its Control -I	Core	4			4
	ENS202CR	Environmental Pollution and its Control -II	Core	4			4
	ENS203CR	Laboratory Course	Core			8	4
Discipline Centric Elective	ENS204DCE	Atmospheric Sciences	DCE	3	1		4
	ENS205DCE	Environmental Microbiology	DCE	3	1		4
	ENS206DCE	Green Environment	DCE	1	1		2
	ENS207DCE	Ecological Tour	DCE			2	2
Generic Elective	ENS208GE	Analytical Instrumentation	GE	1	1		3
	ENS209GE	Applied Microbiology and Toxicology	GE	1	1		2
Open Elective	ENS210OE	Environmental Issues	OE	1	1		3
	ENS211OE	Global Environmental Problems	OE	1	1		2

3rd SEMESTER

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	ENS301CR	Natural Resources	Core	4			4
	ENS302CR	Environmental Impact Assessment	Core	4			4
	ENS303CR	Laboratory Course	Core			8	4
Discipline Centric Elective	ENS304DCE	Environmental Laws	DCE	3	1		4
	ENS305DCE	Environmental Biotechnology	DCE	3	1		4
	ENS306DCE	Remote Sensing and GIS	DCE	1	1		2
	ENS307DCE	Ecological Tour (Ladakh)	DCE			2	2
Generic Elective	ENS308GE	Crenobiology	GE	1	1		2
	ENS309GE	Understanding of Enzymology	GE	1	1		2
Open Elective	ENS310OE	Environmental Protection	OE	1	1		2

4th SEMESTER

Course	Course Code	Course Name	Paper category	Hours/Week			Credits
				L	T	P	
Core	ENS401CR	Environmental Engineering	Core	4			4
	ENS402CR	Biodiversity and Resource Management	Core	4			4
	ENS403CR	Project Work	Core			8	4
Discipline Centric Elective	ENS404DCE	Aquatic Ecology	DCE	3	1		4
	ENS405DCE	Terrestrial Ecology	DCE	3	1		4
	ENS406DCE	Environmental Planning and Auditing	DCE	1	1		2
	ENS407DCE	Restoration Ecology	DCE	1	1		2
Generic Elective	ENS408GE	Industrial Ecology	GE	1	1		2
	ENS409GE	Herbal Medicine	GE	1	1		2
Open Elective	ENS410OE	Sustainable Development	OE	1	1		2

Course Descriptions 1st Semester

CORE COURSES

ENS101CR: Fundamentals of Environmental Science (04 credits)

Credit I: Components of environment

- 1.1. Definition, principle and scope of environmental science
- 1.2. Atmosphere: Structure and composition
- 1.3. Hydrosphere and cryosphere: Hydrological cycle
- 1.4. Lithosphere: Structure and composition
- 1.5. Biosphere: Components

Credit II: Ecosystem dynamics

- 1.1. Structure and function of ecosystems
- 1.2. Ecosystem resilience
- 1.3. Primary productivity
- 1.4. Secondary productivity
- 1.5. Energy flow, energy models and energy relations in ecosystems

Credit III: Population and community ecology

- 1.1. Characteristics of population
- 1.2. Population growth and population interactions
- 1.3. Population regulation: Density dependent and density independent
- 1.4. Concept and characteristics of communities
- 1.5. Ecological succession, primary and secondary processes in successions, climax community and types of climax

Credit IV: Meteorology

- 1.1. Meteorological parameters: Atmospheric pressure, temperature, precipitation, humidity and wind
- 1.2. Radiation and heat budget
- 1.3. Atmospheric stability
- 1.4. Temperature inversions
- 1.5. Wind roses

ENS102CR: Environmental Chemistry (04 credits)

Credit I: Analytical chemistry

- 1.1. Stoichiometry
- 1.2. Titrimetry and gravimetry
- 1.3. Potentiometry (pH and conductivity)
- 1.4. UV-visible and flame photometry
- 1.5. Atomic absorption spectrophotometry

Credit II: Atmosphere 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. Chemistry of green house gasses

Credit III: Water chemistry

- 1.1. Physico-chemical characteristics 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
- 1.5. Redox potential

Credit 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. Biochemical properties of soil
- 1.5. Soil classification and types

ENS103CR: Laboratory Course

(04 credits)

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. Demonstration 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 and acidity of water samples
9. Estimation of pH, conductivity and alkalinity of soil samples
10. Estimation of free carbon dioxide content in water samples
11. Estimation of chloride content in different water and soil samples
12. Estimation of cations (calcium, magnesium, sodium, potassium) in water samples
13. Estimation of cations (calcium, magnesium, sodium, potassium) in soil samples
14. Experimental verification of Beer-Lambert's law
15. Determination of primary productivity aquatic habitats
16. Determination of primary productivity in terrestrial habitats
17. Study of dose – effect relationships in important toxicants/pollutants
18. Study of leaf pigment by paper chromatography and TLC methods
19. Estimation of protein and carbohydrate content in biological samples
20. Collection and identification of the fish fauna of different aquatic habitats

DISCIPLINE CENTRIC ELECTIVE

ENS104DCE: Environmental Geoscience

(04 credits)

Credit 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

Credit II: Natural hazards and disaster management

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

Credit III: Marine systems

- 1.1. Marine zones
- 1.2. Composition of seawater
- 1.3. Marine resources and their recycling
- 1.4. Ice sheets and fluctuations of seawater
- 1.5. Ocean conveyor belt

Credit 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. Geochemical cycles - C, N, P, S
- 1.5. Concept of residence time and rate of natural cycles

ENS105DCE: Environmental Toxicology

(04 credits)

Credit I: Principles of toxicology

- 1.1. Definition, scope, goals and divisions of toxicology
- 1.2. Factors influencing toxicity, toxicity of chemical mixtures
- 1.3. Factors affecting environmental concentration of toxicants,
- 1.4. Dose - response relationship
- 1.5. Toxicity testing methods (single & multi species, acute, sub-acute and chronic toxicity)

Credit II: Biotransformation of xenobiotics

- 1.1. Membranous barriers, binding, storage and absorption of xenobiotics
- 1.2. Excretion of xenobiotics
- 1.3. Biotransformation: General principles and types of biotransformation
- 1.4. Cytochrome P 450, its variants and their role
- 1.5. Glutathione – S- transferase, its variants and their role

Credit 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

Credit IV: Toxicants as public health hazard

- 1.1. Pesticides and heavy metals.
- 1.2. Radioactive substances and food additives
- 1.3. Automobile emissions.
- 1.4. Occupational diseases: Principles and methods of occupational health.
- 1.5. Evaluation and control of occupational health hazards.

ENS106DCE: Mountain Ecology

(02 credits)

Credit I: Mountains ecology

- 1.1. Mountain ecosystem: Goods and services
- 1.2. Major mountains systems of the world: Himalayas, Alps, Andes
- 1.3. Ecological specializations in high altitude ecosystems
- 1.4. Impacts of climate change on mountain ecosystems
- 1.5. Mountain policy support: Land use dynamics, poverty and food security

Credit II: Himalayan resources

- 1.1. Glacier resources
- 1.2. Forests and forestry
- 1.3. Medicinal plants
- 1.4. Flora and fauna of Jammu & Kashmir
- 1.5. Energy resources of Jammu & Kashmir (Hydel and Solar)

ENS107DCE: Human and Environment

(02 credits)

Credit I: Environmentalism

- 1.1. Environmentalism: Concept and history
- 1.2. Environmental organizations (WWF, UNEP, IUCN, WHO)
- 1.3. Environmental movements in India: Narmada dam, Tehri dam, Almatti dam and Chipko
- 1.4. The monetization frontier
- 1.5. Environmental politics

Credit II: Environmental education and psychology

- 1.1. Environmental education
- 1.2. Environmental protection and religious teachings
- 1.3. Public awareness and role of NGOs
- 1.4. Environmental psychology and current problems
- 1.5. Environmental ethics

GENERIC ELECTIVE

ENS108GE: *Invitro* Plant Morphogenesis and Regeneration (02 credits)

Credit I

- 1.1. Morphogenesis and cellular totipotency
- 1.2. Callus Cultures: Establishment of callus, callus growth and subculture
- 1.3. Cytodifferentiation: Dedifferentiation and redifferentiation
- 1.4. Organogenesis: caulogenesis, rhizogenesis
- 1.5. Factors affecting cellular differentiation and organogenesis

Credit II

- 1.1. Somatic embryogenesis: initiation, basic requirements, embryo maturation and plantlet development
- 1.2. Micropropagation: Definition, stages and techniques of micropropagation
- 1.3. Problems encountered in micropropagation
- 1.4. Applications of micropropagation.
- 1.5. Synthetic seeds

ENS109GE: Genotoxicity (2 Credits)

Credit I

- 1.1. Necrosis, apoptosis and inflammation
- 1.2. Somatic and genetic risk of environmental pollutants.
- 1.3. Cancer latency, threshold and non-threshold model of cancer
- 1.4. Mechanism of chemical carcinogens (free radicals and alkylating agents)
- 1.5. Classification of carcinogens (physical, chemical and biological agent)

Credit II

- 1.1. Ames test and micronucleus test
- 1.2. Chromatid and chromosome aberration
- 1.3. Screening, tier testing and test batteries for mutagenicity testing
- 1.4. FISH technique
- 1.5. Use of Comet assay in environmental toxicology

OPEN ELECTIVE

ENS110OE: Environmental Ethics and Sociology (2 Credits)

Credit 1

- 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

Credit 2

- 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

ENS110OE: Basics of Ecology and Environment

(3 credits)

Credit I: Understanding Environment

- 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

Credit II: Understanding Ecosystems

- 1.1 Structure and functions,
- 1.2 Food chains, foodwebs, flow of energy
- 1.3 Ecological Pyramids
- 1.4 Ecological Succession
- 1.5 Ecological Interactions

Credit III: Natural and managed ecosystems

- 1.1 Natural Ecosystems (forests, grasslands, wetlands and deserts)
- 1.2 Managed ecosystems (Agri ecosystems and urban ecosystems)
- 1.3 Ecosystem goods and services
- 1.4 Natural and human induced changes in ecosystems
- 1.5 Strategies to ensure sustainability of ecosystems

Course Descriptions 2nd Semester

CORE COURSES

ENS201CR: Environmental Pollution and its Control – I (04 credits)

Credit I: Air pollution

- 1.1. Sources, classification and properties of primary and secondary air pollutants
- 1.2. Pollutant's behaviour in atmosphere
- 1.3. Smog and acid rain
- 1.4. Ozone layer depletion
- 1.5. Global warming and climate change

Credit 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 green house gases
- 1.5. Bio-filters for control of air pollution

Credit III: Noise pollution and its control

- 1.1. Noise pollution: definition and sources
- 1.2. Measurement of noise
- 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

Credit IV: Thermal and radioactive pollution and their control

- 1.1. Thermal pollution: causes and consequences
- 1.2. Control of thermal pollution
- 1.3. Radioactive pollution: causes and consequences
- 1.4. Types of radioactive pollutants and their sources
- 1.5. Radioactive waste management and control

ENS202CR: Environmental Pollution and its Control – II (04 Credits)

Credit 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 heavy metals and their interaction with soil components

Credit 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

Credit III: Water pollution

- 1.1. Sources and types of water pollution
- 1.2. Lake eutrophication and stream pollution
- 1.3. Petroleum hydrocarbons and marine pollution
- 1.4. Ground water pollution
- 1.5. Biocides, heavy metals and their impact on aquatic life

Credit IV: Control of water pollution

- 1.1. Water and waste water standards
- 1.2. Control of eutrophication and restoration of lakes and wetlands
- 1.3. Role of microbes in pollution abatement
- 1.4. Role of aquatic plants in pollution abatement
- 1.5. Control of Stream and groundwater pollution

ENS203CR: Laboratory Course

(04 credits)

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) in different water samples
7. Estimation of phosphorus (inorganic, organic and total) in different waters
8. Estimation of phosphorus and nitrogen content in different soil samples
9. Estimation of dissolved silica and sulfate in different water bodies
10. Determination of SO_x, NO_x and particulate matter (PM) in ambient air
11. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
12. Study of ambient noise levels in different zones
13. Qualitative and quantitative estimation of phytoplankton community in different aquatic habitats
14. Qualitative and quantitative estimation of periphyton community in different aquatic habitats
15. Qualitative and quantitative analysis of zooplankton in relation to eutrophication
16. Application of diversity indices in aquatic and terrestrial ecosystems
17. Biochemical tests for different enzymes
18. Preparation of bacterial smears and gram staining
19. Estimation of bacterial population in different water samples by culture technique
20. Estimation of fungal population in different habitats through culture techniques

DISCIPLINE CENTRIC ELECTIVE

ENS204DCE: Atmospheric Science

(04 credits)

Credit I: The atmosphere

- 1.1. Introduction to atmospheric science
- 1.2. Atmospheric dynamics
- 1.3. Basic structure and mechanism of atmospheric general circulation,
- 1.4. Monsoon systems, cyclones, anticyclones, jet streams, ENSO
- 1.5. Air-sea interactions

Credit II: Climatology

- 1.1. Fundamentals of climatology
- 1.2. Classification of climate: Koppen's and Trewartha
- 1.3. Climatic zones of India
- 1.4. Climate of J&K
- 1.5. Paleo-climatology and climate change

Credit 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

Credit 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. Climate modeling

ENS205DCE: Environmental Microbiology

(04 credits)

Credit I: Microbial ecology

- 1.1. History and scope of microbiology
- 1.2. General account of micro-organisms
 - a. Bacteria
 - b. Fungi, algae and viruses
 - c. Protozoa
- 1.3. Interactions between microbes and other organisms
- 1.4. Factors affecting growth of microorganisms
- 1.5. Brief introduction to thermophiles, barophiles, acidophiles, alkalophiles and psychrophiles

Credit II: Microbes and environment

- 1.1. Nature and function of micro-organisms in soil, water and air
- 1.2. Microbial spoilage of food and its preservation
- 1.3. Microbial activity in sewage disposal
- 1.4. Application of micro-organisms in the control of

- a. Oil pollution
 - b. Chemical pollution - pesticides, synthetic polymers, and metals
 - c. Bio-deterioration of materials
- 1.5. Role of microbes in fixation and solubilization / mineralization of nutrients: carbon, nitrogen, phosphorus, sulphur

Credit III: 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)
 - a. Air borne diseases: tuberculosis, influenza viruses
 - b. Soil borne diseases: tetanus and gas-gangrene
 - c. Water and food borne diseases: cholera, typhoid, giardiasis, hepatitis
- 1.4. Allergic diseases
- 1.5. Insect vectors of human diseases like malaria, dengue, encephalitis, and their control

Credit IV: Industrial microbiology

- 1.1 Major products of industrial microbiology - Antibiotics, amino acids and biopolymers.
- 1.2 Fermentation technology and bioprocessing
- 1.3 Role of microbiology in metallurgy.
- 1.4 Basic techniques in molecular biology - PCR and electrophoresis
- 1.5 Biosafety levels in microbiology labs.

ENS206DCE: Green Environment

(02 Credits)

Credit II: Ecotourism

- 1.1. Ecotourism: concept and significance
- 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

Credit IV: Green cities

- 1.1. Concept of green buildings and cities
- 1.2. Green belt
- 1.3. Consumer behavior
- 1.4. Sustainable urban traffic management
- 1.5. Green city: a case study

ENS207DCE: Ecological Tour

(02 credits)

During 2nd semester, students are required to go for institutional visit to various academic and research institutions outside Jammu & Kashmir carrying 02 credits and will form a component of Elective Allied. One credit will be given for participation and one credit for Tour report and viva voce.

GENERIC ELECTIVE

ENS15208GE: Analytical Instrumentation

(03 credits)

Credit I

- 1.1.Principle and applications of microscopy
- 1.2.Fluorescent, confocal and electron microscopy
- 1.3.Principle of centrifugation and types of centrifugation
- 1.4.Rotors and types of Rotors
- 1.5.Ultracentrifugation and its applications

Credit II

- 1.1.Chromatography-Basic Principle and its classification
- 1.2. Ion-exchange Chromatography
- 1.3.Gel- permeation Chromatography and its applications
- 1.4.Gas liquid Chromatography/GC-MS
- 1.5.HPTLC and HPLC

Credit III

- 1.1. Visible and UV spectroscopy
- 1.2. Spectro-fluorimetry
- 1.3. Electrophoresis-PAGE, SDS-PAGE
- 1.4. PCR , its variants and its applications
- 1.5. BLOT techniques like Southern blotting, Northern blotting and Western blotting

ENS15209GE: Applied Microbiology and Toxicology

(02 credits)

Credit I

- 1.1.Introduction to Microbiology
- 1.2.Functions of microorganisms in the environment
- 1.3.Role of microorganisms in wastewater treatment and solid waste management
- 1.4.Microorganisms and human health
- 1.5.Role of microorganisms in metallurgy

Credit II

- 1.1.Principles of toxicology
- 1.2.Ecological concept of xenobiotic and recalcitrant toxicants,
- 1.3.Factors affecting the toxic response, chemical interactions of toxicants
- 1.4.Concept of LD₅₀, LC₅₀
- 1.5.Toxicants as health hazards

OPEN ELECTIVE

ENS15210OE: Environmental Issues

(03 credits)

Credit 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

Credit II

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

Credit III

- 1.1. Natural resource management
- 1.2. Control of air pollution
- 1.3. Control of water pollution
- 1.4. Control of soil pollution
- 1.5. Control of noise and radioactive pollution

ENS15211OE: Global Environmental Problems

(02 Credits)

Credit I

- 1.1 Acid rain
- 1.2 Ozone depletion
- 1.3 Deforestation
- 1.4 Biodiversity loss
- 1.5 Global warming and climate change

Credit II

- 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

Course Descriptions 3rd SEMESTER

CORE COURSES

ENS301CR: Natural Resources

(4 credits)

Credit I: Mineral resources

- 1.1. Classification of mineral resources
- 1.2. Metals and minerals from land and their global distribution
- 1.3. Metals and minerals from oceans and their global distribution
- 1.4. Metals and mineral deposits in India with special reference in J&K
- 1.5. Environmental consequences of mineral exploitation

Credit II: Water resources

- 1.1. Inventory of earth's water resources: Surface and groundwater
- 1.2. Water resources of India with special reference to Kashmir
- 1.3. Global water budget
- 1.4. Surface and ground water resources: Global consumption pattern
- 1.5. Water resource management

Credit 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

Credit 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

ENS302CR: Environmental Impact Assessment

(04 credits)

Credit I: Fundamentals of EIA

- 1.1. Environment impact assessment: Concept, objectives and approaches
- 1.2. Strategic environmental assessment
- 1.3. EIA guidelines 2006 and amendments
- 1.4. Protocol for environment impact statements
- 1.5. Public participation in environmental decision making

Credit II: EIA methodologies

- 1.1. EIA methods
- 1.2. Baseline data generation
- 1.3. Air and water quality assessment
- 1.4. Ecological assessment
- 1.5. Social impact assessment

Credit III: EIA Case studies

- 1.1. Hydro power, irrigation and drainage
- 1.2. Industrial estates and Parks
- 1.3. Highways and Railways
- 1.4. Thermal power projects
- 1.5. Cement and Chemical industries

Credit IV: Ecological modeling

- 1.1. Role of models in ecology
- 1.2. Components of a model
- 1.3. Classes of mathematical models
- 1.4. Models of population (growth and interaction) and pollutant dispersal
 - a. Lotka – Volterra model
 - b. Leslie’s matrix model
 - c. Gaussian plume model
- 1.5. Modeling of air quality, water quality and noise characteristics

ENS303CR: Laboratory Course

(04 credits)

Course Contents

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

DISCIPLINE CENTRIC ELECTIVE

ENS304DCE: Environmental Laws

(04 credits)

Credit 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)
- 1.4. CITES (1973)
- 1.5. Earth Summit

Credit 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. The Water (Prevention and Control of Pollution) Act (1974) as amended up to (1988) and rules (1975)
- 1.4. The Air (Prevention and Control of Pollution) Act as amended by amendment Act (1987) and rules (1982)
- 1.5. The Environmental (Protection) Act (1986)

Credit 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. The EPA rules (1986)

Credit IV: National Laws-III

- 1.1. Biological diversity Act (2002)
- 1.2. Public liability insurance act (1991)
- 1.3. Intellectual property rights and patent act (2005)
- 1.4. National environment tribunal act (1995)
- 1.5. National green tribunal act (2010)

ENS305DCE: Environmental Biotechnology

(04 credits)

Credit I: Introduction to environmental biotechnology

- 1.1. Biotechnology
 - a. Concept and environmental relevance
 - b. Environmental risks
- 1.2. Elementary information of gene transfer, brief account of cloning vehicles
- 1.3. Recombinant DNA technology and its applications.
- 1.4. Environmental Genomics: A key to understanding biology, pathophysiology and disease
- 1.5. Molecular taxonomy: documenting biodiversity by DNA barcoding

Credit II: Eco-friendly role of animals

- 1.1. Vermiculture technology
 - a. Earth worms and soil productivity
 - b. Earthworm culture and vermi-composting

- 1.2. Aquaculture improvement through biotechnology
- 1.3. Fish farming through biological wastes
- 1.4. Stem cell and animal cloning
- 1.5. Biological control of insects -definition, principles and control mechanisms

Credit III: In-vitro storage of plants

- 1.1 Tissue culture: Concept and importance
- 1.2 Micropropagation: Techniques and application
- 1.3 Conservation: Short term, medium term and long term
- 1.4 Recent developments in cryopreservation
- 1.5 Biotechnology in biodiversity conservation: Germplasm conservation , Gene banks and DNA banks

Credit IV: Biotechnology in environmental management

- 1.1. Biosensors and bioindicators
- 1.2. Biotechnology in pollution control
- 1.3. Biodegradation and bioremediation
- 1.4. Emerging environmental biotechnological trends
- 1.5. Genetically modified organisms and bio-safety: a general account

ENS306DCE: Remote Sensing and GIS

(02 credits)

Credit 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 interpretation and processing
- 1.5. Aerial photographs and their types on the basis of look angle

Credit II: Geographic information system

- 1.1. Global positioning system : Basic principles and functioning
- 1.2. Development of GIS, functional requirements of GIS: hardware configuration and software modules
- 1.3. Geographic data: Spatial and non-spatial, data models: raster and vector
- 1.4. Remote sensing and GIS integration
- 1.5. Application of remote sensing and GIS in:
 - a. Monitoring and management of biodiversity
 - b. Integrated watershed development and
 - c. Environmental impact assessment

ENS307EA: 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.

GENERIC ELECTIVE

ENS308GE: Crenobiology

(02 Credits)

Credit I

- 1.1.Springs as critical biotopes
- 1.2.Classification of springs
- 1.3.Spring discharge and biology of spring biotopes
- 1.4. Delineation of spring protection zones
- 1.5.Vulnerability assessment and mapping of spring waters

Credit II

- 1.1.Inventory and monitoring of springs
- 1.2.Spring water geochemistry and recharge
- 1.3.Springs as ecosystems
- 1.4. Case study of major springs
- 1.5.Conservation and management of spring ecosystems

ENS309GE: Understanding of Enzymology

(02 Credits)

Credit I

- 1.1.Historical perspectives of enzymology
- 1.2.Classification of enzymes
- 1.3. Enzyme assay and enzyme activity units
- 1.4.Nature of enzymes
- 1.5.Factors affecting enzyme activity.

Credit II

- 1.1.Enzyme kinetics
- 1.2.Michaelis- Menton equation and its modification
- 1.3.Enzyme inhibition
- 1.4.Basic concept of Isozymes and allosteric enzymes
- 1.5.Clinical significance of enzymes

OPEN ELECTIVE

ENS310OE: Environmental Protection

(02 Credits)

Credit I

- 1.6. Role of an individual in conservation of natural resources
- 1.7. General idea about environmental laws
- 1.8. International conventions (Stockholm declaration)
- 1.9. Kyoto protocol and Montreal protocol
- 1.10. Earth summit

Credit 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

Course Descriptions 4th SEMESTER

CORE COURSES

ENS401CR: Environmental Engineering

(04 credits)

Credit I: Fundamentals of environmental engineering

- 1.1. Environmental engineering: Introduction and scope
- 1.2. Sewage and storm water drainage
- 1.3. Planning of housing drainage
- 1.4. Environmental sanitation
- 1.5. Ventilation and air conditioning

Credit II: Drinking water treatment

- 1.1. Methods of water purification: flocculation, sedimentation, sedimentation with coagulation
- 1.2. Filtration: sand filters, pressure filters, horizontal filters
- 1.3. Disinfection and desalination of water
- 1.4. Chemical treatment: adsorption, gas stripping, ion exchange
- 1.5. Reverse osmosis and distillation

Credit III: Sewage treatment

- 1.1. Wastewater treatment plants: Concept, methods and design
 - a. Primary
 - b. Secondary
 - c. Tertiary
- 1.2. Sludge and its disposal techniques
- 1.3. Natural methods of sewage disposal
- 1.4. Biology of sewage treatment
- 1.5. Reclamation and reuse of industrial and domestic wastewater

Credit IV: Solid and hazardous waste management

- 1.1. Solid wastes: sources, generation and their characteristics
- 1.1. Hazardous waste: sources and generation and their characteristics
- 1.2. Disposal and management of solid, industrial and hazardous wastes,
- 1.3. Hospital waste management
- 1.4. Site remediation

ENS402CR: Biodiversity and Resource Management

(04 credits)

Credit 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

Credit 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

Credit 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

Credit 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

ENS403CR: Project Work

(04 credits)

The project work shall be of practical nature and the candidate has to carry out the project work related to environment under the supervision of concerned teacher.

The distribution should be as follows:

- **Part I:** Identification of problem area and general description
- **Part II:** Study of specific literature in detail pertaining to the statement of the problem
- **Part III:** Developing a solution, methodology or proposing a hypothesis to solve the problem
- **Part IV:** Experimental analysis, results, discussion, conclusion and recommendations

Each student has to submit the dissertation of the project work for evaluation. The student has to give seminar (internal) and vivo voce (external) of the project work.

DISCIPLINE CENTRIC ELECTIVE

ENS404DCE: Aquatic Ecology

(04 credits)

Credit I: Freshwater ecology

- 1.1. Aquatic ecosystem services
- 1.2. Aesthetic values of lakes and rivers
- 1.3. Paleolimnology
- 1.4. Trophic dynamics in aquatic ecosystems
- 1.5. Role of phytoplankton and zooplankton

Credit 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 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

Credit 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

Credit IV: Groundwater ecology

- 1.1. Groundwater ecology and hydrology
- 1.2. Vertical distribution of groundwater, Darcy's law and its validity
- 1.3. Types of aquifers and their classification
- 1.4. Subterranean ecosystems and biodiversity
- 1.5. Groundwater quality and management

ENS405DCE: Terrestrial Ecology

(04 credits)

Credit 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

Credit II: Soil and landscape ecology

- 1.1. Soil process and ecosystem functioning
- 1.2. Soil biology
- 1.3. Concept of landscape ecology
- 1.4. Tools and approaches in landscape ecology
- 1.5. Application of landscape ecology

Credit 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

Credit IV: Desert and grassland ecology

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

ENS406DCE: Environmental Planning and Auditing

(02 credits)

Credit I

- 1.1.Environmental planning – importance and objectives
- 1.2.Land use planning
- 1.3.Urban development and environmental planning
- 1.4.Rural development and environmental planning
- 1.5. Role of ethics, aesthetics and science in environmental planning

Credit II

- 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

ENS407EA: Restoration Ecology

(02 credits)

Credit 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. Ecological principles of the restoration of native ecosystems

Credit 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. Measuring progress and success of restoration programs

GENERIC ELECTIVE

ENS408GE: Industrial Ecology

(02 credits)

Credit I

- 1.1. Basic principles of green chemistry
- 1.2. Application and need of green chemistry
- 1.3. Concept of green economy, green growth and low carbon development
- 1.4. Introduction to industrial ecology and its relation to the concept of sustainability
- 1.5. Principles and objectives of industrial ecology

Credit II

- 1.6. Industrial symbiosis, industrial ecosystems and eco industrial parks
- 1.7. Ecology and biomimicry
- 1.8. Future and challenges of industrial ecology
- 1.9. Concept of green technology
- 1.10. Ecomark scheme and eco-friendly products

ENS409GE: Herbolology

(02 credits)

Credit I

- 1.1. History of herbal medicines
- 1.2. Introduction to medicinally important plant parts
- 1.3. Classification of medicinal plants
- 1.4. Ecological status of medicinal plants with special reference to Jammu & Kashmir
- 1.5. Applications of herbal medicines

Credit II

- 1.1. Pharmacodynamics and pharmacokinetics of herbal medicines
- 1.2. Cultivation and post harvest technology of medicinal plants
- 1.3. General methods, types and principles of extraction
- 1.4. Purification of extracts using chromatographic methods including HPLC and GC
- 1.5. General methods for determining the structure of herbal compounds

OPEN ELECTIVE

ENS410OE: Sustainable Development

(2 credits)

Credit I

- 1.1. Concept and strategies of sustainable development
- 1.2. Principles of ecological economics – scope and usefulness
- 1.3. Prey-predator and supply-demand cycles
- 1.4. Environment and trade
- 1.5. Sustainability of society, resources and framework

Credit II

- 1.1. Valuation of ecosystem services
- 1.2. Natural resources accounting
- 1.3. Landmark events in sustainability (Agenda 21)
- 1.4. Changes in institutional and environmental governance framework
- 1.5. Moving towards sustainability: An Indian perspective