

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KASHMIR, SRINAGAR- 190006**

M.Sc. in Environmental Sciences (2014)

Course Descriptions

The two year (four semesters) postgraduate course in environmental sciences will be based on 96 credits (twenty four 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), 16 elective allied (minimum of 8 credits to be opted) and 4 elective open credits. The paper scheme for the examination will be decided as per the policy of the university in the later stages.

FIRST SEMESTER

Course Code	Course Name	Paper category	Hours/week			Credits
			L	T	P	
ENS14101CR	Fundamentals of Environmental Sciences	Core	4	0	0	4
ENS14102CR	Environmental Chemistry	Core	4	0	0	4
ENS14103CR	Laboratory Course	Core	0	0	8	4
ENS14104EA	Natural Resources	Elective (Allied)	4	0	0	4
ENS14105EA	Environmental Geoscience	Elective (Allied)	4	0	0	4
ENS14106EA	Mountain Ecology and High Altitude Environment	Elective (Allied)	4	0	0	4
ENS14107EA	Man and Environment	Elective (Allied)	4	0	0	4
ENS14108EO	Plant Morphogenesis, Cytogenotoxicity & Herbal Medicine	Elective Open	-	-	-	4
Total						32 Credits

ENS14101CR: Fundamentals of Environmental Sciences (04 credits)

Credit I: Components of environment (16 hrs)

- 1.1. Definition, principle and scope of Environmental Science
- 1.2. Atmosphere: Structure and composition
- 1.3. Hydrosphere: Global water resources and hydrological cycle
- 1.4. Lithosphere: Structure and composition
- 1.5. Biosphere: Components

Credit II: Ecosystem dynamics (16 hrs)

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

Credit III: Population and community ecology (16 hrs)

- 1.1. Characteristics of populations
- 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 (16 hrs)

- 1.1. Meteorological parameters: Atmospheric pressure, temperature, precipitation, humidity, radiation and wind
- 1.2. Heat transferring processes
- 1.3. Atmospheric stability
- 1.4. Inversions and mixing heights
- 1.5. Wind roses

ENS14102CR: Environmental Chemistry (04 credits)

Credit I: Analytical chemistry and techniques (16 hrs)

- 1.1. Stoichiometry
- 1.2. Titrimetry and gravimetry
- 1.3. Principle and working of pH and conductivity meter
- 1.4. Spectrometry and flame photometry
- 1.5. Atomic absorption and emission spectrophotometry

Credit II: Chemistry of atmosphere (16 hrs)

- 1.1. Particles, ions and radicals in the atmosphere
- 1.2. Chemical processes for formation of inorganic and organic particulate matter
- 1.3. Thermo-chemical and photochemical reactions in the atmosphere and their effects
- 1.4. Chemistry of oxygen, ozone and other oxidants
- 1.5. Chemistry of green house gasses

Credit III: Water chemistry (16 hrs)

- 1.1. Physico-chemical characteristics of water
- 1.2. Solubility of gases in water; dissolved gases in water - CO₂, DO, H₂S and NH₃
- 1.3. Biochemical oxygen demand and chemical oxygen demand
- 1.4. Carbonate-bicarbonate system
- 1.5. Redox potential

Credit IV: Soil chemistry (16 hrs)

- 1.1. Soil profile and pedogenesis
- 1.2. Physico- Chemical properties of soils
- 1.3. Inorganic and organic components of soil
- 1.4. Biochemical properties of soil
- 1.5. Soil classification (USDA) and types

ENS14103CR: Laboratory Course (04 credits)

Course Contents

1. Estimation of volume of a water body: Pond, pool, lake
2. Estimation of rate of flow of water
3. Determination of the soil texture in different terrestrial habitats: Agriculture land, wasteland, forest, desert and alpine pastures
4. Estimation of meteorological parameters
5. Determination of latitude, longitude and altitude of a place
6. Study of major rock types
7. Determination of light intensity in different habitats
8. Standardization of reagents – titrants (acids, bases)
9. Determination of pH, conductivity, alkalinity and acidity of water samples
10. Estimation of pH, conductivity, alkalinity and acidity of sediment and soil samples
11. Estimation of free carbon dioxide content in polluted and unpolluted waters
12. Estimation of chloride content in different water bodies
13. Estimation of chloride content in different soil samples
14. Estimation of cations (calcium, magnesium, sodium, potassium) water samples
15. Estimation of cations (calcium, magnesium, sodium, potassium) soil samples
16. Determination of Beer-Lambert's law
17. Determination of primary productivity in terrestrial and aquatic habitats

18. Study of the pharmacognostic characters of important medicinal plants
19. Collection and Identification of common aquatic macrophytes
20. Collection and identification of the fish fauna of different aquatic habitats

ENS14104EA: Natural Resources

(4 credits)

Credit I: Mineral resources

(16 hrs)

- 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

(16 hrs)

- 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

(16 hrs)

- 1.1. Animal resources: Current status with special reference to India
- 1.2. Forest resources of India: Timber and non timber
- 1.3. Rangelands
- 1.4. Fishery resources of India
 - a. Inland
 - b. Marine
- 1.5. Fishery resources of J&K

Credit IV: Energy resources

(16 hrs)

- 1.1. Renewable energy resources
 - a. Solar energy
 - b. Wind and tidal energy
 - c. Geothermal energy
 - d. Hydropower energy
 - e. Energy from biomass
- 1.2. Hydrogen as a source of energy
- 1.3. Non-renewable energy Resources
 - a. Coal
 - b. Petroleum
 - c. Natural gas
- 1.4. Nuclear energy
- 1.5. Concept of green fuels

ENS14105EA: Environmental Geoscience**(04 credits)****Credit I: Earth science****(16 hrs)**

- 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**(16 hrs)**

- 1.1. Concept of natural hazards
- 1.2. Causes and environmental consequences of
 - a. Earth quakes and Tsunami
 - b. Volcanoes
 - c. Landslides
 - d. Floods and droughts
 - e. Cloudbursts
 - f. forest fires
 - g. Cyclones
- 1.3. Risk assessment and vulnerability analysis
- 1.4. Disaster management: Preparedness, response, rehabilitation and failures (case studies)
- 1.5. Hazards policies and agencies

Credit III: Marine systems**(16 hrs)**

- 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**(16 hrs)**

- 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

ENS14106EA: Mountain Ecology and High Altitude Environment**(04 credits)****Credit I: High altitude environment****(16 hrs)**

- 1.1. Concept of high altitude environment
- 1.2. Ecological specializations in high altitude ecosystems
- 1.3. Mountain ecosystem: Goods and services
- 1.4. Altitudinal demographic
- 1.5. Major mountains systems of the world: Himalayas, Alps, Andes

Credit II: High altitude ecosystems**(16 hrs)**

- 1.1. High altitude vegetation and its comparison with other ecological types
- 1.2. High altitude lakes and wetlands

- 1.3. Alpine terrestrial ecosystem
- 1.4. High altitude animals
 - a. Invertebrates
 - b. vertebrates
- 1.5. Effects of High-altitude environment on morphology of insects

Credit III: Challenges in mountains (16 hrs)

- 1.1. Impacts of climate change on mountain ecosystems
- 1.2. Changes in the mountain cryosphere
- 1.3. Resilience and adaptation of socio-ecological mountain systems to global change
- 1.4. Health and mountains
- 1.5. Mountain policy support: Land use dynamics, poverty and food security

Credit IV: Himalayan resources (16 hrs)

- 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

ENS14107EA: Man and Environment (04 credits)

Credit I: Environmentalism (16 hrs)

- 1.1. Environmentalism: Concept and history
- 1.2. Environmental organizations (WWF, UNEP, IUCN, WHO) and conferences
- 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 sociology (16 hrs)

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

Credit III: Environmental education and psychology (16 hrs)

- 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

Credit IV: Environmental economics (16 hrs)

- 1.1. Environmental economics: Definition and scope
- 1.2. Population, poverty and environment
- 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

ENS14108EO: Plant morphogenesis, Cyto-genotoxicity & Herbal Medicine (04 credits)

Credit I: Plant morphogenesis and regeneration (16 hrs)

- 1.1. Initiation, nutrition and maintenance of plant cell and tissue culture
- 1.2. Cellular totipotency, initiation of callus cultures and its characteristics
- 1.3. Cell differentiation and organogenesis
- 1.4. Suspension culture
- 1.5. Tissue culture studies of some threatened medicinal plants of Kashmir Himalaya

Credit II: Herbal medicine and health care (16 hrs)

- 1.1. Traditional Herbal Medicines for Healthcare and Management of Human diseases
- 1.2. Medicinal and aromatic materials from plants
- 1.3. Benefits of Medicinal and aromatic plant materials
- 1.4. Industrial utilization of medicinal plants
- 1.5. Phytochemical and anti microbial studies of some medicinal plants

Credit III: Cyto-genotoxicity (16 hrs)

- 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 IV: Toxicogenomics (Testing protocols) (16 hrs)

- 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

Bibliography

- Environmental Science. Botkin, Keller
- Environmental Science. Cunningham, Saigo
- Environmental Science. Jackson & Jackson

- Environmental Science. Tyler Miller
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Physical Geology. Monroe & Wicander
- Concepts of Ecology. E.J. Kormondy
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Environment: Principles & Applications. Chris Park.
- Earth Systems. W.G. Ernst
- Environmental Science - Physical Principles & Applications. Boeker & Grondelle
- Fundamentals of Physical Environment. Briggs, Smithson, Addison & Atkinson
- Atmosphere, Weather & Climate. R.G. Barry & R.J. Chorley
- Geosystems: An Introduction to Physical Geography. Robert W. Christopherson
- Introducing Physical Geography. Alan Starhler & Arthur Starhler
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Soils in our Environment. Miller and Gardiner
- Fundamentals of Soils. J. Gerrard
- Environmental Science. Enger and Smith
- Basics of Environmental Science. Michael Allaby
- Principles of Environmental Science. Cummingham and Cunningham
- Environmental Sciences (System and Solutions). Mckinney and Schoch
- Principles of atmospheric physics and chemistry. Goody
- Smoke, Dust and Haze. S K Friedlander
- General Climatology. H. J. Critchfield
- Environmental Chemistry. IAN Williams
- Environmental Chemistry. A. K. De
- Environmental Chemistry. Stanley E. Manahan
- An Introduction to Analytical Chemistry. S.A. Iqbal & M. Satake
- Chromatography of Environmental Hazards. Lawrence Fishbein
- Principles of Biochemistry. Wilson Walker
- Electron Spin Resonance. J.E. Wertz And J.R. Bolton
- Analytical Chemistry. D. Kealey And P.J. Haines
- Text Book of Quantitative Chemical Analysis. G.H. Jeffery, J. Basset, J. Mendham and R.C. Denney
- The Surface Chemistry of Soils. Garrison Sposito
- The Nature & Properties of Soils. Brady & Weil
- Soils in our Environment. Miller and Gardiner
- Soil Genesis and Classification. Boul, Hole & Mccacken
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Text Book Of Limnology. Gerald A. Cole
- Limnology. R. G. Wetzel
- Limnology. Jacobson
- A Treatise on Limnology (Vol I – III). G. E. Hutchinson
- Limnology. Goldman and Horne
- Limnology. P. S. Welch
- Soil in the environment. Daniel Hillel
- Weathering (An introduction to scientific principles). Bland and Rolls
- Soil fertility and fertilizers. Havlin et al.
- Soil erosion and its control. R P C Morgan.
- Soil properties. Liu and Evett
- Soil science and management. Edward J Plaster
- Soils (An introduction). Singer and Munns
- Basic concept of environmental chemistry. Des W Connel
- Basic physical chemistry of the atmospheric science. Peter V Hobbs

- Environmental chemistry. Fritz Helmet
- Introductory chemistry for environmental science. Harrison and De Mora
- An introduction to environmental chemistry. Andrews et al.
- Stream ecology. Barness and Mishall
- Analytical mass spectrometry. Budde
- Primary Productivity of the Biosphere. Helmut Lieth & Robert H. Whittaker
- Tropical Ecosystems & Ecological Concepts. Patnick L. Osborne
- Concepts of Ecology. E.J. Kormondy
- Ecology & Environmental Management. C.C. Park
- Ecology of a Changing Planet. Mark B. Bush
- Ecology for Environmental Sciences: Biosphere, Ecosystems & Man. J. M. Anderson
- Fundamentals of Ecology. E.P. Odum
- Instant Notes in Ecology. Mackenzie, Ball & Virder
- Primer of Ecological Theory. Jonathan Roughgarden
- Ecology with special reference to Animals and Man. S. Charles, Kendeigh
- Evolutionary Ecology. Eric R. Pianka
- A Primer of Ecology. Nicholas J. Gotelli
- Ecology Theories and Applications. Peter Stiling
- Applied Ecology and Natural Resource Management. Guy R. Mcpherson and Stephen Destefano
- Population Ecology. Begon & Mortimer
- Geosystems: An Introduction to Physical Geography. Robert W. Christopherson
- Physical Geology. Plummer, Mc. Geary, Carlson
- Physical Geology. Monroe & Wicander
- Essentials of Geology. Chernicoff, Fox, Venkatakrishnan
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Introducing ecology. Cotgreave and Forseth
- Community ecology. Diamond and Case
- Community ecology. R J Putman
- Biodiversity and conservation. Michael J Jeffries
- Environmental Geology: Principles & Practice. Fred G. Bell
- Physical Geology. Monroe & Wicander
- Economic Geography - A Study of Resources. Prithwish Roy
- Environmental Science. Cunningham, Saigo
- Fish & Fisheries of India. V.G. Jhingram
- Concepts of Ecology. E.J. Kormondy
- River Jhelum, Kashmir Valley. L. Nyman
- Natural Resources and Environmental Technology. Jasper S Lee
- Himalayan Glaciers. Naseerudin Ahmed, Sarwar Rais
- Wildlife Wilderness. G.A.Bhat
- Range ecology. Humphrey
- Flowers of the Himalaya. Adam Stainton
- Wildlife resources. Anderson.
- Microclimate - The Biological Environment, 2nd ed. Normal J. Rosenverg, Blaine L. Blad, Shashi B. Verma
- Atmospheric Change. Graedel and Crutzen
- Atmospheric, Weather and Climate. R.G. Barrey and R.J. Chorley
- Geosystems- An Introduction to Physical Geography. Robert W. Christopherson
- Physical Geology. Plummer, Mc. Greary, Carlson
- Essentials of Geology. Wicander & Monroe
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen

- The Global Casino. Nick Middleton
- Natural Hazard Mitigation. Godschalk, Beatley, Berke, Brower & Kaiser
- Active Tectonics. E. Keller & N.Pinter
- Environmental Chemistry. M. Satake & Y. Mido
- Earths Dynamic Systems. W.K. Hamblin & E.H. Christiansen
- Physical Geology. Wicander & Monroe
- Environmental Chemistry. Stanley E. Manahan
- Environmental Chemistry. M. Satake, Y. Mido, M.S. Sethi & S. A. Iqbal
- Environmental Chemistry. Ian Williams
- Our Geologic Environment. H. Blatt
- Environment. Raven, Berg and Johnson
- Environmental Science. Botkin, D.B. and Keller, E.A.
- Environmental Science. Nebel, B.J. and Wright, R.T.
- Environmental Geography. Marsh, W.M. and Grossa, Jr. J.M.
- Environmental Oceanography. Abel, D.C. and Mc Connell, R.L.
- Resources of the Earth. Craig, J.R., Vaughan, D.J. and Skinner, B.J.
- Natural Hazards and Disasters. Hyndman, D. and Daudley, N. (Editors)
- Environmental Geochemistry. Eby, G.N.
- Environmental Hydrogeology. Soliman, M.M., LaMoreaux, P.E., Memon, B.A.,
- Mineralogy. Perkins, D. Assad, F.A. and LaMoreaux, J.W.
- Environmental Law, the Economy and Sustainable Development. Revesz, Sands and Stewart
- Higher Education in India. Mehraj-ud-Din
- Environmental Economics and Policy. Tietenberg
- Issues in Environmental Economics. Hanley and Roberts
- Importance of Wildlife Conservation from Islamic Perspective. H.S.A. Yahya
- Psychology. Jhon J. Seamon, Douglas and T. Kenrick
- Society in Focus – Introduction to Sociology. William E. Thompson and Joseph V. Hickey
- Clinical Approach to Rural Development. E.D. Setty
- Environmental psychology. Annete Bolger
- Environment and Society. Francis Moore
- Environmental Economics-A Critical Overview. Alan Gilpin
- The economics of the environment and natural resources. R.Quentin Graflon et al.

General Instructions for the Candidates

1. The first semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KASHMIR, SRINAGAR- 190006
KASHMIR**

M.Sc. in Environmental Sciences

Course Descriptions

2nd SEMESTER

Course Code	Course Name	Paper category	Hours/ week			Credits
			L	T	P	
ENS14201CR	Environmental Pollution and its Control -I	Core	4	0	0	4
ENS14202CR	Environmental Pollution and its Control -II	Core	4	0	0	4
ENS14203CR	Laboratory Course	Core	0	0	8	4
ENS14204EA	Environmental Toxicology	Elective (Allied)	4	0	0	4
ENS14205EA	Atmospheric Sciences	Elective (Allied)	4	0	0	4
ENS14206EA	Restoration Ecology	Elective (Allied)	4	0	0	4
ENS14207EA	Green Environment	Elective (Allied)	4	0	0	4
ENS14208EA	Ecological Tour	Elective (Allied)			2	2
ENS14209EO	Analytical Instrumentation & Environmental Concerns	Elective Open	-	-	-	4
Total						34 Credits

ENS14201CR: Environmental Pollution and its Control - I
(Air, Noise and Radioactive Pollution) **(04 credits)**

Credit I: Air pollution **(16 hrs)**

- 1.1. Sources, classification and properties of primary and secondary air pollutants
- 1.2. Pollutant 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 **(16 hrs)**

- 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, gaseous air pollution - SO_x, NO_x, CO and green house gases
- 1.4. Plume Rise and Design of Stack height
- 1.5. Bio-filters and control of air pollution

Credit III: Noise pollution and its control **(16 hrs)**

- 1.1. Noise pollution: Definition and sources
- 1.2. Measurement of Noise and sound pressure level,
- 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 its control **(16 hrs)**

- 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

ENS14202CR: Environmental Pollution and its Control - II
(Soil and Water Pollution) **(04 Credits)**

Credit I: Land degradation and soil pollution **(16 hrs)**

- 1.1. Causes and kinds of land degradation and Soil Pollution
- 1.2. Desertification: causes, consequences
- 1.3. Soil erosion: causes, assessment and environmental impacts
- 1.4. Fate 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 **(16 hrs)**

- 1.1. Control of soil pollution
- 1.3. Soil conservation and control of soil erosion

- 1.2. Waste lands and their reclamation
- 1.4. Sustainable agricultural practices
- 1.5. Integrated pest management

Credit III: Water pollution

(16 hrs)

- 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 and Heavy metals and their impact on aquatic life

Credit IV: Control of water pollution

(16 hrs)

- 1.1. Water and waste water standards
- 1.2. Control of eutrophication and restoration of lakes
- 1.3. Wetland conservation
- 1.4. Role of aquatic plants in pollution abatement
- 1.5. Control of Stream pollution and Groundwater Management

ENS14203CR: Laboratory Course

(04 credits)

Course Contents

1. 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, COD and dissolved organic matter in different waters
5. Estimation of organic carbon and organic matter in different soils samples
6. Estimation of nitrogen (NH_3 , NO_2 and NO_3) and phosphorus (ortho- and total) in different waters
7. Estimation of phosphorus and nitrogen content in different soil samples
8. Estimation of dissolved silica and sulphate in different water bodies
9. Estimation of gaseous pollutants (SO_x , NO_x) and SPM in industrial emissions
10. Determination of SO_x , NO_x and SPM in ambient air
11. Qualitative and quantitative estimation of phytoplankton and periphyton community in different aquatic habitats
12. Qualitative and quantitative analysis of zooplankton in relation to eutrophication
13. Study of leaf pigment by paper chromatography and TLC methods
14. Comparative anatomical study of mesophytes, hydrophytes and xerophytes
15. Chemical characterization of ground water
16. Study of dose – effect relationships in important toxicants/pollutants
17. Estimation of protein and carbohydrate content in biological samples
18. Application of diversity indices in aquatic and terrestrial ecosystems
19. Spring and stream order classification
20. Biochemical tests for different enzymes

ENS14204EA: Environmental Toxicology**(04 credits)****Credit I: Principles of toxicology****(16 hrs)**

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

Credit II: Biotransformation of xenobiotics**(16 hrs)**

- 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**(16 hrs)**

- 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**(16 hrs)**

- 1.1. Pesticides
- 1.2. Heavy metals
- 1.3. Radioactive substances
- 1.4. Food additives
- 1.5. Automobile emissions

ENS14205EA: Atmospheric Sciences**(04 credits)****Credit I: The atmosphere****(16 hrs)**

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

Credit II: Climatology**(16 hrs)**

- 1.1. Fundamental of climatology
- 1.2. Classification of climate: Koppen's and Thornthwaite

- 1.3. Climatic zones of India, monsoons
- 1.4. Climate of J&K and Western disturbances
- 1.5. Paleo-climatology and climate change

Credit III: Atmospheric aerosols (16 hrs)

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

Credit IV: Observational techniques (16 hrs)

- 1.1. Conventional measurements of pressure, temperature, humidity, wind, precipitation, visibility, clouds, soil temperature and humidity
- 1.2. LIDARS, SODARS, weather RADARS
- 1.3. Remote-sensing techniques (WP-RASS)
- 1.4. Measurements of particulate matter, SO_x and NO_x,
- 1.5. Ocean temperature, salinity, wave height, currents, self recording instruments, radiosondes, radiometersondes, ozone sonde

ENS14206EA: Restoration Ecology (04 credits)

Credit I: Concepts in restoration ecology (16 hrs)

- 1.1. The basic principles and concepts of restoration ecology
- 1.2. Spatial dynamics: Metapopulations, corridors, dispersal & refugia
- 1.3. Characteristics of degraded ecosystems
- 1.4. Attributes of restored ecosystems, reference conditions, range of variability
- 1.5. Ecological indicators in restoration

Credit II: Restoration ecology (16 hrs)

- 1.1. Theory and practice of restoring animal and plant diversity
- 1.2. Case studies on restored freshwater wetlands, forests, prairies and reintroduced species populations
- 1.3. Ecological principles of the restoration of native ecosystems
- 1.4. Establishment (site preparation, selection of seed mixes, planting techniques) and management (fire, mowing, weed control) of native vegetation
- 1.5. Evaluation of restorations

Credit III: Restoration planning (16 hrs)

- 1.1. Goals and objectives
- 1.2. Adaptive management and monitoring
- 1.3. Social science aspects of restoration
- 1.4. Policy instruments in restoration ecology
- 1.5. Funding and legislating restoration

- Credit IV: Human dimensions of restoration** (16 hrs)
- 1.1. Ethics of restoration
 - 1.2. Role of public-private partnership in restoration
 - 1.3. Human dimensions of restoration; practical constraints
 - 1.4. Current uncertainties and controversies in restoration ecology
 - 1.5. Restoration and climate change

ENS14207EA: Green Environment (04 Credits)

Credit I: Green chemistry (16 hrs)

- 1.1. Basic principles of green chemistry
- 1.2. Atom economy and sustainable development
- 1.3. Application and need of green chemistry
- 1.4. Concept of green technology
- 1.5. Ecomark scheme and eco-friendly products

Credit II: Ecotourism (16 hrs)

- 1.1. Ecotourism: Concept, history, principles and significance
- 1.2. Tourism in National Parks, sanctuaries, wetlands and other landscapes
- 1.3. Ecotourism and economics, ecolodge definition management and guidelines
- 1.4. Ecotourism potential in J&K
- 1.5. Ecotourism guidelines for nature and tour operators, ecotourism certification

Credit III: Green economy (16 hrs)

- 1.1. Concept of Green Economy, green growth and low carbon development
- 1.2. Green jobs, perspectives of Green economy
- 1.3. Low emission development strategies
- 1.4. Green economy: Policy tool kits
- 1.5. International actions to support green growth in LDCs

Credit IV: Green Cities (16 hrs)

- 1.1. Concept of green buildings and cities
- 1.2. Green belt
- 1.3. Consumer behaviour
- 1.4. Sustainable urban traffic management
- 1.5. Green infrastructure development

ENS14208EA: 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.

ENS14209EO: Analytical Instrumentation & Environmental Concerns (04 credits)

Credit I: Instrumentation-I (16 hrs)

- 1.1. Principle and applications of microscopy
- 1.2. Fluorescent, confocal and electron microscopy
- 1.3. Principle of centrifugation and its applications
- 1.4. Ultracentrifugation and its applications
- 1.5. Chromatography-gel chromatography, GLC, HPLC

Credit II: Instrumentation-II (16 hrs)

- 1.1. Visible and UV spectroscopy
- 1.2. Spectro-fluorimetry
- 1.3. Electrophoresis-PAGE, SDS-PAGE
- 1.4. PCR & agarose gel electrophoresis
- 1.5. BLOT techniques

Credit III: Environmental security (16 hrs)

- 1.1. Overview of Environmental security and conflict
- 1.2. Neo-malthusians and political ecologists
- 1.3. Oil and water conflict
- 1.4. Armed conflict and environment
- 1.5. Climate change and conflict

Credit IV: Electromagnetic pollution (16 hrs)

- 1.1. Cell phone problem
- 1.2. Cell phone use patterns
- 1.3. Radiofrequency (RF) exposure from cell phones, headsets, mobile towers etc
- 1.4. Radio frequency exposure of various age groups
- 1.5. Health risks of Electromagnetic pollution

Bibliography

- Environmental Chemistry. Stanley E. Manahan
- Global Warming – A Science of Climatic Change. Frances Draki
- Environmental Chemistry. Fratz Helmet
- Indoor Air Pollution. Richard Wadden & Peter Scheff
- Air Pollution and Plant Life. J.N. Bell & M. Treshow
- Basic concepts of Environmental Chemistry. Connell, D.W.
- Global Environmental Risk. Kasperson and Kasperson.
- Global Environmental Change. Hidore, J.J.
- Climate Change. Burroughs, W.J.
- Global Warming. Johansen, B.E.
- Global Warming. Brown, P.
- Soils and the environment: An introduction. Wild, A.
- Soils in Our Environment. Miller, R.W. and Donahue, R.L.
- Fundamentals of soils. Gerrard, J.
- The nature and properties of soils. Brady, N.C. and Weil, R.R.

- Soil Erosion and its control. Morgan, R.P.C. (Editor.)
- Soil in the environment. Hillel, D.
- Environmental Soil Science. Tan, K.H.
- Soil and water contamination. van der Perk, M.
- Soil fertility and fertilizers. Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, W.L.
- Geoenvironmental Sustainability. Yong, R.N., Mulligan, C.N. and Fuke, M.
- Principles of Crop Production. Acquah, G.
- Natural Resources. Holecheck, J.L., Cole, R.A., Fisher, J.T. and Valdez, R.
- Forest restoration in landscapes – Beyond planting trees. Mansourian, S., et al. (Editors)
- Utilization of Forest Resources. Wadoo, M.S.
- Lakes Handbook. O’Sullivan, P.E. and Reynolds, C.S.
- Groundwater Science. Fitts, C.R.
- Groundwater and Surface Water Pollution. Liu, D.H.F. and Liptak, B.G.
- Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication. IETC Technical Publication.
- River Channel Management. Downs and Gregory.
- Wetlands: Monitoring, Modelling and Management. Okruszko, T., Maltby, E., et al.
- Creating freshwater wetlands. Hammer, D.A.
- Primary Energy. Present Status and Future Prospectives. Thielheim, K.O. (Editor)
- Environmental Engineering. Gilberts, M.
- Environmental Engineering. Sincero, A.P. and Sincero, G.A.
- Environmental Engineer’s Handbook. Liu, D.H.F. and Liptak, B.G.
- Wastewater Engineering. Metcalf and Eddy
- Water and Wastewater Technology. Hammer and Hammer.
- Basic Environmental Technology. Nathenson, Jerry. A.
- Environmental Toxicology. M. Satake, Y. Mido, M.S. Sethi , et al.
- Introduction to Toxicology. J. Timbrell
- Introductory Chemistry for Environmental Sciences. Harrison and Mora
- The Handbook of Environmental Chemistry: Vol III Part A. O. Hutzinger
- Environmental Toxicology. Ming-Ho-Yu
- Toxicology: The Basic Science of Poison. Klaassen, C.D.
- Principles and Methods of Toxicology. Hayes, A.W.
- Statistics in Ecotoxicology. Sparks, T. (Editor).
- Basic Toxicology: Fundamentals, Target organs, and Risk Assessment. Lu
- Toxicology of Insecticides. Matsumura, F.
- Water contamination and health. Wang, R.G.M. (Editor).

General Instructions for the Candidates

1. The second semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 8 credits (2 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (Open) from outside the parent Department/ offered by any other Department/Faculty.
5. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KASHMIR, SRINAGAR – 190006
KASHMIR**

M.S. in Environmental Sciences

Course Descriptions

3rd SEMESTER

Course Code	Course Name	Paper category	Hours/week			Credits
			L	T	P	
ENS14301CR	Environmental Impact Assessment & Ecological Modeling	Core	4	0	0	4
ENS14302CR	Environmental Engineering	Core	4	0	0	4
ENS14303CR	Laboratory Course	Core	0	0	8	4
ENS14304EA	Environmental Laws	Elective (Allied)	4	0	0	4
ENS14305EA	Environmental Statistics, Research Methodology & Information Technology	Elective (Allied)	4	0	0	4
ENS14306EA	Environmental Microbiology	Elective (Allied)	4	0	0	4
ENS14307EA	Remote Sensing and GIS	Elective (Allied)	4	0	0	4
ENS14308EA	Ecological Tour (Ladakh)	Elective (Allied)			2	2
ENS14309EO	Aquatic Environments & Environmental Biophysics	Elective Open	-	-	-	4
Total						34 Credits

ENS14301CR: Environmental Impact Assessment & Ecological Modeling (04 credits)

Credit I: Fundamentals of EIA (16 hrs)

- 1.1. Environment impact assessment: Concept, objectives and approaches
- 1.2. Baseline data generation and 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 (16 hrs)

- 1.1. EIA methodology
- 1.2. Air and water quality assessment
- 1.3. Ecological assessment
- 1.4. Social impact assessment
- 1.5. EIA case studies:
Hydel, industrial estates, highways, thermal and nuclear power projects, cement and chemical industries

Credit III: Environmental auditing and planning (16 hrs)

- 1.1. Principles and guidelines of environmental auditing; ISO 14000 series
- 1.2. Preparation and submission of audit report
- 1.3. Environmental planning: Importance and objectives
- 1.4. Land use planning
- 1.5. Urban and rural development and environmental planning

Credit IV: Ecological modeling (16 hrs)

- 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. Modelling of air quality, water quality and noise characteristics

ENS14302CR: Environmental Engineering (04 credits)

Credit I: Basics of environmental engineering (16 hrs)

- 1.1. Environmental Engineering: Introduction and scope
- 1.2. Sewage and Storm water drainage
- 1.3. Planning of housing drainage and rural sanitation
- 1.4. Environmental sanitation: Ventilation and air conditioning
- 1.5. Ecological sanitation

Credit II: Drinking water treatment (16 hrs)

- 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 (16 hrs)

- 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 (16 hrs)

- 1.1. Sources and generation of solid wastes and their characteristics
- 1.2. Methods of disposal of solid wastes.
- 1.3. Hospital waste management
- 1.4. Hazardous waste: Source, transportation, treatment, storage and disposal
- 1.5. Management of solid, industrial and hazardous wastes and Site remediation

ENS14303CR: Laboratory Course (04 credits)

Course Contents

1. Preparation of bacterial smears and gram staining
2. Estimation of bacterial population in different water samples by culture technique
3. Estimation of fungal population in different habitats through culture techniques
4. Case studies based on environmental laws
5. Survey of different residential areas for determining the prevalence of different air, water, soil and food borne diseases
6. EIA – Leopold Matrix method and Case studies
7. Socio-economic studies – preparing of questionnaire and Case studies
8. Computation of standard deviation, standard error and coefficient of variation
9. Computation of Correlation and Regression
10. One way and two way classification of ANOVA
11. Computation of Post hoc tests using statistical software
12. Preparation of different pollution themes with the help of MS PowerPoint
13. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
14. Land use / land cover classification from satellite data
15. Delineation of drainage of a given area from satellite data
16. Delineation of point, line and polygon themes
17. Preparation of thematic maps using R. S. maps.

18. Working and design of treatment plants
19. Study of effect of wastewater - treatment on seed germination
20. Study of morphogenetic response of explants on media

ENS14304EA: Environmental Laws

(04 credits)

Credit I: Environmental Protection

(16 hrs)

- 1.1. Environment protection: Issues and problems
- 1.2. National efforts on environmental protection, laws and policy in India
- 1.3. International efforts for environment protection (Stockholm, montreal, kyoto protocol & earth summit)
- 1.4. CITES (1973), Biodiversity act (2002) and Espoo convention (1991)
- 1.5. Indus Water Treaty (1960)

Credit II: National Laws-I

(16 hrs)

- 1.1. Provisions of constitution (article 21,48A, 51A, and 253)
- 1.2. Indian forest act (1927), forest conservation act (1980) and rules (1981)
- 1.3. Wildlife protection act (1972) and amended (2002) and J & K wildlife (protection) act (1978) as amended in (2002)
- 1.4. The Water (Prevention and Control of Pollution) act (1974) as amended up to (1988) and rules (1975)
- 1.5. The air (prevention and control of pollution) act as amended by amendment act (1987) and rules (1982)
- 1.6. The environmental (protection) act (1986) and rules (1986)

Credit III: National Laws-II

(16 hrs)

- 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. Environmental related laws in J&K (brief description)

Credit IV: National Policy

(16 hrs)

- 1.1. National forest policy (1988)
- 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)

**ENS14305EA: Environmental Statistics, Research Methodology
& Information Technology**

(04 credits)

Credit I: Environmental statistics (16 hrs)

- 1.1. Basic elements and tools of statistical analysis:
 - a. Measurement of central tendency: Mean, mode and median.
 - b. Dispersion: Mean deviation, standard deviation, standard error and coefficient of variation
 - c. Probability, Normal, poisson and binomial distribution
- 1.2. Hypothesis testing: Sampling & test of significance: Student's t- distribution, F distribution, Chi Square distribution,
- 1.3. Simple and multiple correlation and regression coefficients
- 1.4. Analysis of variance
- 1.5. Post hoc tests in ANOVA: LSD, Tukey

Credit II: Research methodology (16 hrs)

- 1.1. Critical evaluation of area of research of the author
- 1.2. Literature review and data mining
- 1.3. Experimental design and methodology, methods of sampling
- 1.4. Data computation, preparation of scientific manuscript and dissertation / thesis
- 1.5. Research ethics, plagiarism, bio-safety and good laboratory practices

Credit III: Basics of computer (16 hrs)

- 1.1. Organization and working of a computer
- 1.2. Computer architecture fundamentals
- 1.3. Hard ware: types of memory - primary and secondary
- 1.4. Software: Windows operating systems; important features of MS word, MS excel, and MS power point
- 1.5. Use of computer in ecological predictions and models

Credit IV: Information technology and environment (16 hrs)

- 1.1. Information and communication technology: Advantages, disadvantages and uses
- 1.2. Information types, quality, needs and data processing - computer as a tool
- 1.3. Data mining and bioinformatics
- 1.4. Computer network and internet
- 1.5. Environmental communication: National and international scenario

ENS14306EA: Environmental Microbiology

(04 credits)

Credit I: Microbial ecology (16 hrs)

- 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 (16 hrs)

- 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 (16 hrs)

- 1.1. Human health and environment: MMR, IMR, Life expectancy, incidence of chronic diseases
- 1.2. Epidemiology (Reservoir of infection, communicability and control)
 - a. Air borne diseases: Tuberculosis, meningitis
 - b. Soil borne diseases: Tetanus and gas-gangarone
 - c. Water and food borne diseases: Cholera, typhoid, giardiasis, hepatitis
- 1.3. Allergic diseases
- 1.4. Insect vectors of human diseases like Malaria, Dengue, Encephalitis, and their control
- 1.5. Status of communicable diseases in India

Credit IV: Environmental and occupational health (16 hrs)

- 1.1. Basic principle of environmental health, Physiological responses of man to relevant stresses in the environment
- 1.2. Occupational Diseases: Principles and methods of occupational health
- 1.3. Industrial Toxicology: The relationship of occupation of hygiene and safety and disease
- 1.4. Evaluation and Control of occupational health hazards
- 1.5. Occupations health surveillance, occupational health control programmes in the context of Indian factories act-case studies

ENS14307EA: Remote Sensing and GIS (04 credits)

Credit I: Remote-sensing (16 hrs)

- 1.1. Definition, scope and its role in environmental science
- 1.2. Basic principles of remote sensing
 - a. Electromagnetic radiation (EMR) and electromagnetic spectrum
 - b. Interaction of EMR with atmosphere
 - c. Spectral reflectance of vegetation, soil and water
- 1.3. Satellite systems: IRS, landsat and IKNOS
- 1.4. IR and microwave remote sensing
- 1.5. Aerial photography
 - a. Definition and specifications for aerial photography

- b. Types of aerial photography
- c. Photogrammetry

Credit II: Image analysis and interpretation (16 hrs)

- 1.1. Fundamentals of image interpretation: Multi concept in image interpretation
- 1.2. Image analysis: Visual and digital, methods of image analysis
- 1.3. Image processing: Image characteristics and formats
- 1.4. Image rectification: Concept and techniques of digital image pre-processing
- 1.5. Image enhancement: Techniques of image enhancement

Credit III: Geographic information system (16 hrs)

- 1.1. Global positioning systems (GPS)
- 1.2. Principles and scope of GIS, use of GIS
- 1.3. Raster and vector GIS analysis
- 1.4. Map projections
- 1.5. Database concepts and types, data quality standards

Credit IV: Applications of remote sensing and GIS (16 hrs)

- 1.1. Environmental Impact assessment
- 1.2. Forest management
- 1.3. Watershed management and marine resources
- 1.4. Monitoring of biodiversity
- 1.5. Natural disaster management and regional planning

ENS14308EA: 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.

ENS14309EO: Aquatic Environments & Environmental Biophysics (04Credits)

Credit I: Oceanography (16 hrs)

- 1.1. Formation and classification of water masses and mixing processes in the oceans
- 1.2. General aspects of ocean currents and circulation
- 1.3. Swell and currents induced by wind
- 1.4. Ocean thermal energy conversion (OTEC)
- 1.5. Vorticity

Credit II: Crenobiology (16 hrs)

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

Credit III: Wetlands (16 hrs)

- 1.1. Wetland management for birds and mammals
- 1.2. Wetland plants
- 1.3. Wetland values and functions
- 1.4. Wetland threats and losses
- 1.5. Ramsar sites in J&K

Credit IV: Environmental biophysics (16 hrs)

- 1.1. Concept and scope of physics with respect to environment
- 1.2. Fundamental and applied aspects of extremely low frequency, radio and microwave fields
- 1.3. Magnetic environments and geomagnetic fields, behavioural changes, therapeutic and diagnostic possibilities.
- 1.4. Energy use and efficiency in buildings, energy losses, calculation of energy losses, energy gains
- 1.5. Health risks of electromagnetic pollution: Radiofrequency (RF) exposure from cell phones, headsets, mobile towers

Bibliography

- Handbook of EIA. Judith Peth.
- The Human Impact on the Natural Environment. Andrew Goudie
- Ecological risk Assessment. Glen W. Sutter
- Environmental Impact Statement. Charles H. Eccleston
- Environmental Impact Assessment. Glasson, Therivel, Chadwick
- Integrated Environmental Planning. James K. Lein
- Handbook of Environmental Impact Assessment (Vol 1-2). Judith Petts
- Ecological Risk Assessment. Glenn W. Suter II
- The Human Impact (Mans Role in Environmental Changes). Andrew Goodie
- Basic Environmental Technology. Nathanson
- Water Pollution Control. Helmer and Hespenhol
- International Environmental Standards Handbook: Olson
- Air Pollution: Godish
- Environmental Engineering- a Design Approach. Arcadio P.Sincero and Gregoria A. Sincero
- Waste water microbiology. Gabriel Bitton
- Waste water and disposal. Paul T.Williams
- Waste water management. Klein Gomes
- Waste water treatment-concepts and design approach. G.L.Karia and R.A.Christian
- Water and waste water technology. Merk.J.Hammer and Mark.J.Hammer Jr.
- Biotreatment of agricultural waste water. Mark E.Huntely
- Sustainable habitats in sustainable urban water management. Wagner, Marsalek and Breil

- Phosphorus and nitrogen removal from municipal waste water –Principles and Practices. Richard Sedlak
- Biofiltration for air pollution control. Joseph S.Devimny, Marc A.Deshusses and Todd S.Webster
- Indoor air pollution characteristics, prediction and control. RA Wadden and PA Scheff
- Environmental Law & Policy in India: S. Divan & A. Rosencranz
- Environmental law, the Economy and Sustainable Development. Revesz, Sands and Stewart
- Handbook of the convention on Biological Diversity: Earth Scan.
- Environmental Law. Wolf and Stanley
- Environment and Legal Dimensions. Ahmad Hussain
- Biostatistical analysis. Jerrold H. Zar
- Biostatistics. Arora Malhan
- Fundamentals of Ecology. E. P. Odum.
- Structured Computer organization. Andrew S. Tanenbaum
- IT Tools and Applications. Macmillan Publishers
- Internet 101, A Beginners Guide to the Internet and the Worldwide Web. Wendy G. Lehnert
- Fundamentals of Information Technology. Alexis Leon & Mathews Leon
- Computer Networks: A Systems Approach. Larry L. Peterson and Bruce S. Davie
- Mathematical Statistics with Applications. Miller and Miller.
- Introduction to Biostatistics and Research Methods. Rao & Richards
- Statistical Methods for Environmental & Agricultural Science. A.Raza Hoshmand
- Fundamentals of Environmental Discharge Modeling. Lorin R. Davis
- Advanced Ecological Theory (Principles & Application). Jacqueline McGlade
- Mathematical Modeling of Biological Systems. Harvey J. Gold
- Multivariate Statistics for the Environmental Sciences. Peter J.A.Shaw
- Bioinformatics Computing. Bryan Bergeron
- Microbiology. Eugene W. Nester; Nancy N. Pearsall; C. Evans Roberts; Martha T. Nester; Mary E. Lidstrom
- Microbes and Man. John Postgate
- Microbiology- Basic principles and Application. Noel R. Rose, Alme L. Barron
- Microbiology in patient care. Josephine A. Morello, H. E. Mizer, M. E. Wilson, P A. Granate
- Environmental Microbiology. W. D. Grant; P. E. Long
- Microbial Ecology: Organisms, Habitats, Activities. Heinz Stolp
- Microbiology. J. Nicklin, K. Graeme-Cook and R. Killington
- Encyclopedia of Environmental Microbiology. P. Holter
- Microbial processes – Promising Technologies for Developing Countries. National Academy of Sciences
- Advances in Microbial Ecology. K. C. Marshall.
- Preventive and Social Medicine. K. C. Park.
- Principles of Fruit Preservation. T. N. Morris
- Muir's Textbook of Pathology. J. R. Anderson
- Introductory Microbiology. Fredrick C. Ross
- The Microbial Challenge, Science, Disease & Public Health. Robrt I. Krasner
- Microbe & Man. John Postgate
- Environmental Microbiology. Maier et.al.
- Subsurface Microbiology & Biogeochemistry. Fredrickson & Fletcher
- Microbial Culture (Introduction to Biotechniques). Isaac & Jennings
- Microbiology in Patient care. Morello et.al.
- Remote Sensing and Image Interpretation. Lillesand and Kiefer
- GIS, Environmental Modelling and Engineering. Allan and Brimicombe
- GIS Basics. Stephenwise

- The GIS Book. George B. and Korte, P.E.
- Remote Sensing for Environmental Science. Erwin Schander
- Environmental Science. Botkin, D.B. and Keller, E.A.
- Environmental Science. Nebel, B.J. and Wright, R.T.
- Wetland and water resource modeling and assessment- A watershed perspective. Wei Ji
- Wetlands Monitoring Modeling and Management. Tomasz Okruszko, Edward Maltby, Ian Szatyowicz, Dorota Swiatek and Wiktor Kotowski
- Watershed and drainage. Drick Deep

General Instructions for the Candidates

1. The 3rd semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core component.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.

**DEPARTMENT OF ENVIRONMENTAL SCIENCES
UNIVERSITY OF KASHMIR, SRINAGAR – 190006
KASHMIR**

M.Sc. in Environmental Sciences

Course Descriptions

4th SEMESTER

Course Code	Course Name	Paper category	Hours/ week			Credits
			L	T	P	
ENS14401CR	Resource Management and Sustainable Development	Core	4	0	0	4
ENS14402CR	Aquatic Ecology	Core	4	0	0	4
ENS14403CR	Terrestrial Ecology	Core	4	0	0	4
ENS14404EA	Project Work*	Elective (Allied)	0	0	8*	8
ENS14405EA	Environmental Biotechnology	Elective (Allied)	4	0	0	4
ENS14406EA	Wildlife Management	Elective (Allied)	4	0	0	4
ENS14407EO	Industrial Ecology & Sustainability	Elective Open	-	-	-	4
Total						32 Credits

*Based on experimental work + project report (Dissertation) /// Compulsory Paper

ENS14401CR: Resource Management & Sustainable Development**(04 credits)****Credit I: Biogeography****(16 hrs)**

- 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**(16 hrs)**

- 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: Conservation priorities**(16 hrs)**

- 1.1. Land resources: Conservation and management
- 1.2. Forest conservation: Social forestry and joint forest management and rural eco-development
- 1.3. Energy crisis and conservation of energy resources
- 1.4. Concept and strategies of sustainable development
- 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, agricultural research institutes

Credit IV: Management of natural resources**(16 hrs)**

- 1.1. Management of mineral resources through sustainable exploitation
- 1.2. Management of fresh water resources
- 1.3. Management of rangelands
- 1.4. Monitoring and management of bio-diversity
- 1.5. Concept of ecological footprint and carbon sequestration

ENS14402CR: Aquatic ecology**(04 credits)****Credit I: Aquatic ecosystems****(16 hrs)**

- 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**(16 hrs)**

- 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 wetlands (16 hrs)

- 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 hydrogeology (16 hrs)

- 1.1. Concept of hydrology and hydrogeology
- 1.2. Vertical distribution of groundwater, Darcy's law and its validity
- 1.3. Types of aquifers and their classification
- 1.4. Groundwater quality in different provinces of India
- 1.5. Inorganic and organic pollution of groundwater resources and their management

ENS14403CR: Terrestrial Ecology (04 credits)

Credit I: Terrestrial ecosystems (16 hrs)

- 1.1. Patterns of terrestrial primary production
- 1.2. Biotic influences
- 1.3. Basic concepts of soil biology
- 1.4. Rangeland ecology
- 1.5. Carbon sequestration potential of terrestrial ecosystems

Credit II: Forest ecology (16 hrs)

- 1.1. Forest & forest environment: Major forest types of world, forest types & forest cover of India
- 1.2. Forest ecosystem structure and function: Primary productivity of forest ecosystems, litter production and decomposition
- 1.3. Forest degradation and deforestation: Causes and consequences
- 1.4. Regeneration ecology of forest
- 1.5. Forest ecosystem management

Credit III: Agro-ecosystems (16 hrs)

- 1.1. Agro-ecosystems: Concept, structural and functional components
- 1.2. Agro-ecosystems: Services and sustainability
- 1.3. Role of biodiversity in agro-ecosystems
- 1.4. Food security and agriculture
- 1.5. Impact of global climate change on agro-ecosystems

Credit IV: Landscape ecology (16 hrs)

- 1.1. Concepts of landscape ecology
- 1.2. The consequences of human land-use and landscape change

- 1.3. Landscape: Structure and processes
- 1.4. Tools and approaches in landscape ecology
- 1.5. Design of conservation reserves

ENS14404EA: Project Work

(08 credits)

It is a special paper where a candidate carries out the application of knowledge in solving/ studying/ exploring a real life/ difficult problem in a creative way. The project work shall be of 8 credits. The project work shall be discipline centric and the candidate has to study the project work on his own with an advisory support by the concerned teacher.

The distribution should be as follows:

- **Part I:** Identification of problem area and literature survey
- **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

ENS14405EA: Environmental Biotechnology

(04 credits)

Credit I: Introduction to environmental biotechnology

(16 hrs)

- 1.1. Biotechnology
 - a. Concept and environmental relevance
 - b. Environmental risks
- 1.2. Biotechnology in Pollution control
- 1.3. Genetically modified organisms and bio-safety: A general account.
- 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

(16 hrs)

- 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

(16 hrs)

- 1.1. Tissue culture: Concept, importance and methodology
- 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: gene banks, germplasm conservation and DNA Banks

Credit IV: Crop improvement through plant tissue culture (16 hrs)

- 1.1. Embryo culture
- 1.2. Anther and Pollen Culture
- 1.3. Protoplast culture
- 1.4. Somaclonal variation, their merits and demerits
- 1.5. Synthetic seeds

ENS14406EA: Wildlife Management (04 credits)

Credit I: Extinction and conservation (16 hrs)

- 1.1. Extinction: Introduction, types and causes
- 1.2. Factors affecting risk of extinction
- 1.3. Population viability analysis as part of recovery plans
 - a. Minimum viable population sizes
 - b. Ecological islands
- 1.4. Captive breeding in animals
- 1.5. Reintroduction of species

Credit II: Threatened species (16 hrs)

- 1.1. Nature of the criteria used to determine the threatened status
- 1.2. Cetartiodactyla (Cervidae and Moschidae)
 - a. Kashmir red deer (*Cervus hanglu*)[†]
 - b. Kashmir musk deer (*Moschus cupreus*)[†]
- 1.3. Cetartiodactyla (Bovidae)
 - a. Markhor (*Capra falconeri*)[†]
 - b. Chiru (*Pantholops hodgsonii*)[†]
- 1.4. Carnivora
 - a. Snow leopard (*Panthera uncial*)[†]
 - b. Himalayan brown bear (*Ursus arctos*)[†]
- 1.5. Passeriformes & Gruiformes
 - a. Kashmir flycatcher (*Ficedula subrubra*)[†]
 - b. Black-necked crane (*Grus nigricollis*)[†]

[†] (Brief background on assessment information, geographic range, population, habitat & ecology, threats and conservation actions)

Credit III: Important bird Areas (16 hrs)

- 1.1. Vegetation characteristics within various biogeographic zones of India
- 1.2. Important bird Areas: Concept, aims, global viewpoint
- 1.3. Objectives and methods of the Indian IBA programme
- 1.4. Globally threatened species of the Indian Trans-Himalayas
- 1.5. Important Bird Areas in Jammu & Kashmir: General overview

Credit IV: Monitoring and evaluation (16 hrs)

- 1.1. Sampling designs for population estimation

- 1.2. Methods of sampling an area: Line transect, belt transect, quadrat, pin frame (point quadrat), permanent quadrat
- 1.3. Mark – Recapture method
- 1.4. Radio telemetry in estimation of animal movement
- 1.5. Data transformations, boot-strap and jack-knife procedure

ENS14407EO: Industrial Ecology & Sustainability

(04 credits)

Credit I: Industrial ecology

- 1.1. Introduction to industrial ecology and its relation to the concept of sustainability
- 1.2. Principles and objectives of industrial ecology
- 1.3. Industrial symbiosis, industrial ecosystems and eco industrial parks
- 1.4. Ecology and biomimicry
- 1.5. Future and challenges of industrial ecology

Credit II: Agriculture meteorology

(16 hrs)

- 1.1. Agro-climatic classifications
- 1.2. Important agro-meteorological parameters
- 1.3. Influence of weather and climate on agriculture
- 1.4. Applications of remote sensing techniques in agricultural meteorology
- 1.5. Agricultural droughts and food shortage

Credit III: Sustainable development

(16 hrs)

- 1.1. Concept and strategies
- 1.2. Brundtland commission (Agenda 21)
- 1.3. Changes in institutional and environmental governance framework
- 1.4. Moving towards sustainability: An Indian perspective
- 1.5. Landmark events in sustainability

Credit IV: Environmental ethics

(16 hrs)

- 1.1. Environmental ethics and philosophy: Introduction
- 1.2. Theories of environmental ethics and philosophy
- 1.3. Different schools of thought vis-à-vis nature and environmental management
- 1.4. Ethics in society: Responsibility for environmental degradation
- 1.5. Eco-centric theories of nature: Deep ecology and animal right theories, environmental rights, environmental racism, SD

Bibliography

- Biodiversity and Conservation. Michael J. Jeffries
- Environmental Biotechnology and Cleaner Bioprocesses. Eugenia J. Olguin, Gloria Sanchez, Elizabeth Hernandez
- Freshwater Aquaculture: R.K. Rath
- Pollution – Ecology and Biotreatment. Mc Eldowney and Waile

- Ponds and Fishculture. C.B. Hall
- Plant Tissue Culture. A.S. Islam
- Aquaculture and Fisheries Biotechnology – Genetic Approaches. R.A. Dunham
- Environmental Geology: Principles & Practice. Fred G. Bell
- Physical Geology. Monroe & Wicander
- Environmental Science. Cunningham, Saigo
- Concepts of Ecology. E.J. Kormondy
- River Jhelum, Kashmir Valley. L. Nyman
- Marine Fisheries Resources. Imtiaz Khan
- Natural Resources and Environmental Technology. Jasper S Lee
- Wildlife Wilderness. G.A. Bhat
- Wetland and water resource modeling and assessment- A watershed perspective. Wei Ji
- Wetlands Monitoring Modeling and Management. Tomasz Okruszko, Edward Maltby, Ian Szatytowicz, Dorota Swiatek and Wiktor Kotowski
- Watershed and drainage. Drick Deep
- Range ecology. Humphrey
- Flowers of the Himalaya. Adam Stainton
- Wildlife resources. Anderson
- Applied Fisheries science. S M Shafi
- Concepts of Ecology. E.J. Kormondy
- Geosystems- An Introduction to Physical Geography. Robert W. Christopherson
- Geoenvironmental Sustainability. Yong, R.N., Mulligam, C.N. and Fuke, M.
- Principles of Crop Production. Acquah, G.
- Natural Resources. Holecheck, J.L., Cole, R.A., Fisher, J.T. and Valdez, R.
- Forest restoration in landscapes – Beyond planting trees. Mansourian, S., Vallauri, D. and Daudley, N. (Editors)
- Utilization of Forest Resources. Wadoo, M.S.
- Limnology. Wetzel, R.G.
- Lakes Handbook. O’Sullivan, P.E. and Reynolds, C.S.
- Groundwater Science. Fitts, C.R.
- Environmental Science. Botkin, D.B. and Keller, E.A.
- Environmental Science. Enger and Smith
- Basics of Environmental Science. Michael Allaby
- Environmental Science. Cunningham & Saigo
- Environmental Science. Tyler Miller
- Environmental Sciences (System and Solutions). Mckinney and Schoch

General Instructions for the Candidates

1. The semester is of 24 credit weightage.
2. A candidate has compulsorily to opt for 12 credits from the core.
3. A candidate has compulsorily to opt for Paper ENS-AEP4 (8 credits) & has a choice to opt for any 4 credits (1 paper) out of the remaining 8 credits (2 papers) offered as Electives (Allied).
4. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four Semester programme) which shall be counted towards the final result of the candidate.